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FRIDAY, JULY 30, 1897.

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THE VEGETATION OF THE HOT SPRINGS OF YELLOWSTONE PARK.

MUCH of the beauty of the so-called 'formations' of Yellowstone National Park lies in the brilliant tints of the mineral deposits, wet from the streams of hot water that issue from the thermal springs and geysers.

Formation is a general term employed to designate any mineral matter deposited by the geysers and hot springs. The amount of formation in the Park is extraordinarily large, but it is chiefly confined to four regions. At Mammoth Hot Springs there is an immense deposit of calcium carbonate, the sides of which are terraced with pulpit-like projecting basins, as is shown in figure 1.*

These interesting basins are formed by the activities of numerous hot springs upon the top and along the sides of the terraces. The entire pile of dazzling white mineral has been likened to the front of a glacier. The Norris Geyser Basin, the Lower Geyser Basin and the Upper Geyser Basin are similar to one another in certain respects. They are extensive expanses of formation chiefly silicious in composition. All of them are situated in the floor of a valley and cover acres on either side of the Firehole River, which flows between banks of snowy whiteness. Upon these formations are scattered the numerous mounds built up by the geysers, and here also are many clear pools of hot water. The latter are of various sizes, some mere shallow puddles which sizzle and sputter, but most of them deep basins with sloping sides, and one at least a pond a hundred yards wide. The water is almost always scalding hot, sometimes even boiling violently in the middle of the pool.

*Figures 1, 5 and 7 are taken from the Ninth Annual Report of the United States Geological Survey.

Dry formation is generally dazzling white, as pure and clear as any snow field of the Alps or Norway. Dry formation reflects the light from innumerable crystals and the rays all seem to focus upon the individual in the proximity. This is why the formation is so hot and blistering. This is why the kodak must be 'stopped down' to its smallest diaphragm if one desires to photograph the geysers, as many a tourist has learned to his sorrow when he viewed the dark brown, over-exposed film of some geyser in action, and then remembered the long wait in the glittering sunshine, the mad rush for favorable points of view and the supreme satisfaction that he felt when the exposure was indexed and described: 'Old Faithful from the west, sunshine upon the vapor clouds, fir forest in the background.'

Wet formation is usually colored. Wherever a stream of water flows from a hot spring the course is marked by streaks of green and yellow along its margin. Fringes and rims of green and gamboge border the boiling pools. Upon the sides of the pulpit basins (see Fig. 1) are flutings of red and orange, of green and brown. The sides and bottoms of the streams are lined with olive colored felts of a velvet-like consistency, and there may be green or brown stringy filaments waving to and fro in the hot currents of water. The sides of many of the pools are covered with green, leathery membranes, or smeared with a coating of structureless jelly. Even the hottest pools, those which are boiling violently in certain parts, are likely to have some of the colored fibrous or gelatinous deposits at their edges. The temperature of the water in these streams and basins is frequently above 80° C., and water boils in Yellowstone Park in the neighborhood of 92° C.

Almost all of this brilliant coloring is associated with growths of low forms of plant life. Some of these organisms it will be our purpose to describe, together with a discussion of certain activities manifested by them in connection with the structure and development of the formation. It is not difficult to see that the growth is various in character in different parts of the hot springs. One finds the most luxuriant masses in such portions of the streams as have cooled down to a relatively low temperature, that is where the water, instead of being scalding hot, may be simply unbearably warm.

Here, at a temperature of from 40°–50° C., flourish a variety of forms with the greatest display of color. The prevailing tints are green, but much of the growth is brown, red or frequently orange. The forms which the masses of vegetation assume depend upon the condition of the environment. If there is a rapid stream the bottom will be covered by a smooth, slippery, leathery felt, and perhaps occasional stringy masses attached at points along the sides and bottom will float out with the current. If water lies in a quiet pool one may find a thick growth of this felt-like character on the bottom and there will be numerous tufts perched upon projecting knobs of rocks. These tufts are made especially prominent by the bubbles of gas entangled in the network of filaments. The tufts are particularly interesting because they give rise to some of the most peculiar sculpturing of the shallow pools.

In warm water, at a temperature of from 55°–65° C. there is a preponderance of green growth, much of it a vivid emerald green. The color becomes less pronounced in warmer portions of the stream, fading to a yellowish brown, and finally becoming light yellow when the water approaches 80° C. in temperature. In the hottest water one finds only white filaments, which grow as long silky strings in the running streams or form a delicate cobweb upon the bottoms of quiet pools. This is the growth that marks

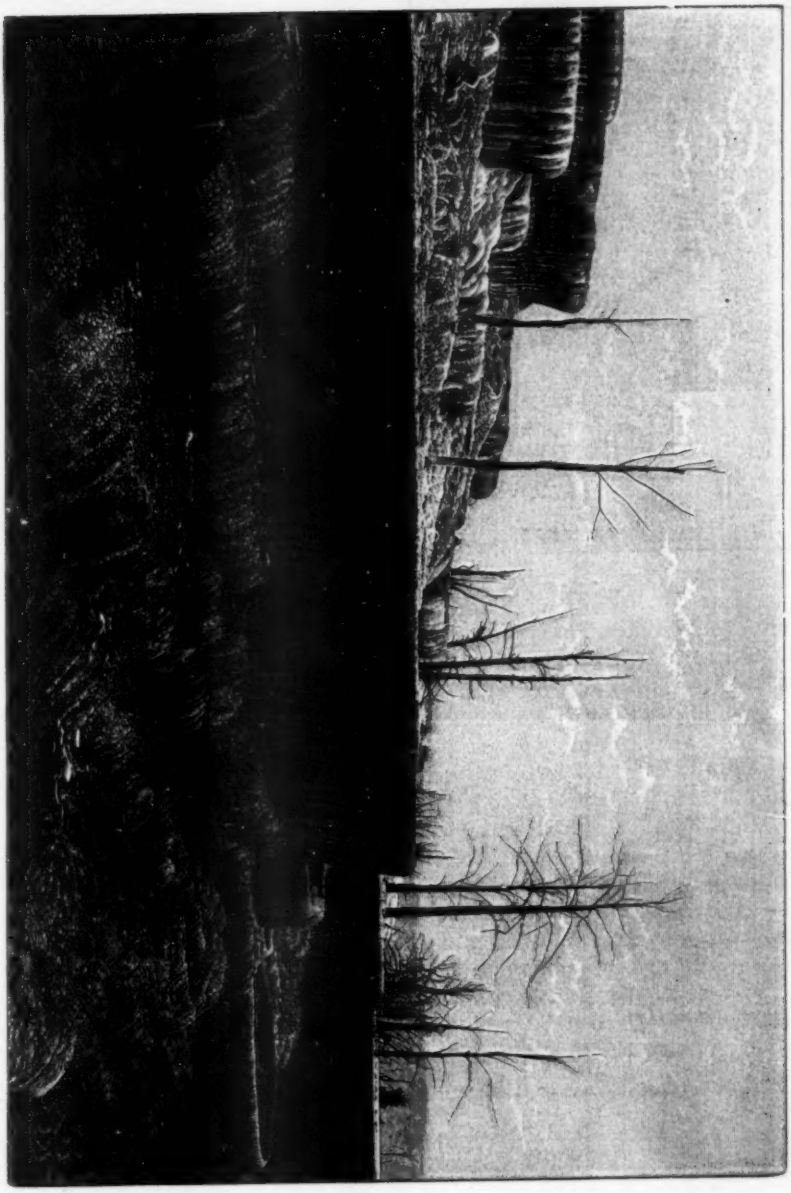

FIG. 1.—Pulpit Basins. Mammoth Hot Springs.

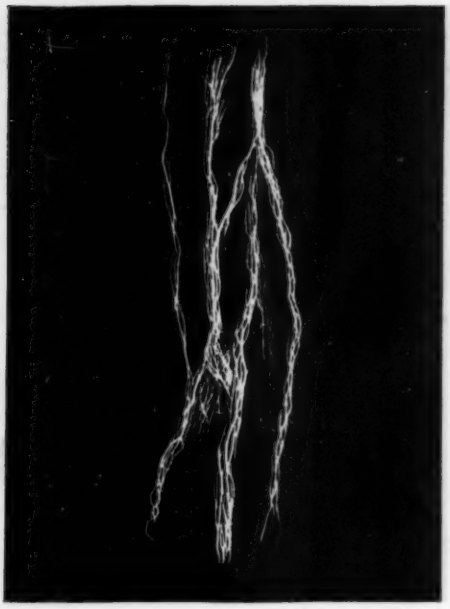

Fig. 2.

the limit of life in these hot springs, and it is not likely to be found in water warmer than 85° C.

Let us now consider the structure of some of the most striking types of plant life making up the vegetation of these hot springs. It would not be wise to go into details, and indeed I cannot well do so, for no one has ever published a critical study of these forms. The subject is really a very difficult one for several reasons. In the first place the organisms are all very minute and can only be studied under the highest powers of the microscope. The characters which define the species are particularly evasive because the forms are extremely simple in structure, and color and size are notoriously variable qualities among such organisms. Then these forms must be carefully compared with the inhabitants of other hot springs, particularly those of Germany and Italy, where such growths have been somewhat extensively studied. This is necessary in order to place the identifications upon a firm basis.

Naturally, the most interesting forms from our point of view are those living in the hottest pools. The growth is usually white or gray; much of it has a pearly luster, and the structure is filamentous. In quiet water it forms a delicate network on the bottom. In the little streams which carry off the overflow from boiling pools one may find the filaments in tufts along the edge. Such tufts often appear as in Fig. 2, but the filaments may grow to be six inches long. The highest temperature of the water in which this growth has been so far reported is 85° C., life conditions which must, indeed, be considered remarkable.

Examined under the microscope, the filaments present some curious features. Under the low powers one sees an apparently homogeneous strand of a gelatinous consistency, shown in Fig. 3, that is coated

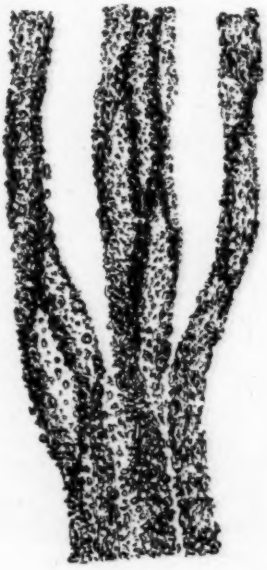

Fig. 3.

all over with small crystals. It is easy to prove that this deposit is sulphur, since the granules can be dissolved away in carbon bi-sulphide, leaving only the gelatinous filament quite soft and flaccid, where it was formerly somewhat stiff and stringy. One sees no further indication of organization until the filament is examined under an immersion lens with, perhaps, a magnification of 1,000 diameters. Even then, to obtain the best results, the specimens must be stained. Such preparations then reveal a remarkable structure. The filament is made up of innumerable bacteria imbedded in a gelatinous matrix. They are chiefly rod-like forms and are arranged in lines and chains. The individual rods vary greatly in length, but it is quite plain that the smaller forms result from the division of the larger. Fig. 4–a illustrates the characteristic form and arrangement of these bacteria under very high magnification, about 2,000 diameters. The long axis of the rods are usually parallel with the general direction of the filament, the width of which is made up of many hundreds of the organisms placed side by side. The filament is really an elongated zoogloea, or colony of bacteria, all coated over with sulphur grains.

It is a difficult matter to determine exactly what form of the bacteria this is. One should know whether the sulphur grains are deposited by the activity of the organism or not. Presumably this is so, and the type is a species of *Beggiatoa*, a genus of bacteria characterized by its peculiar habit of depositing sulphur from water containing sulphuretted hydrogen in solution. But the genus *Beggiatoa* is remarkable because it includes some of the largest species of bacteria known, and the cells are of such a size that many sulphur grains may be contained in their interior. There are without question species of *Beggiatoa* in the hot springs of the Park, and it may be just as well to compare one of these forms shown in Fig. 4–b, under magnification of 500 diameters, with the organism under consideration. It will be seen that the cells of the *Beggiatoa* filament are very large in comparison with those of Fig. 4–a, although the magnification of the latter is about 2,000 diameters. The dark dots in the interior

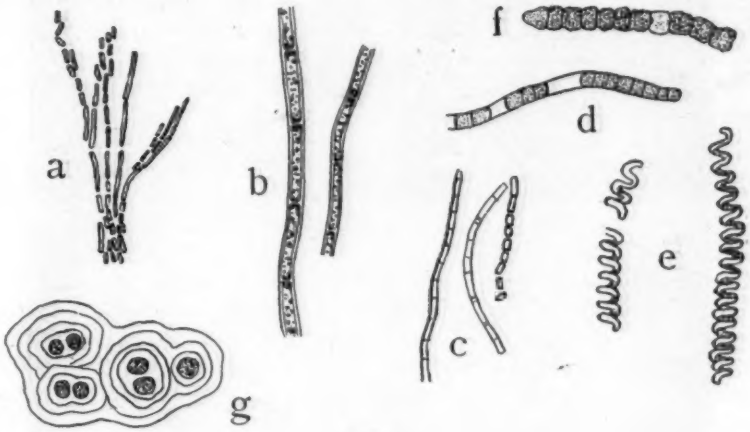

FIG. 4.

FIG. 5.—A Piece of Travertine.

of the cells are sulphur granules. If our plant is not *Beggiatoa* it would be classified as a *Bacillus* because of the rod-like character of the cells. The writer will not attempt to name it on the insufficient data, and it serves as an excellent illustration of the difficulties with which one contends in attempting to define precisely the relations of these organisms to one another. It is a very interesting form from its habits and its habitat, and probably the most adventurous organism in the hot springs.

This peculiar species of the bacteria leaves a record of itself in the mineral deposits in the following manner. The filaments, at first delicate and exceedingly flexible, become coated with such a thick deposit of sulphur and calcium carbonate that they lie as stiff fibers along the edges of the hot pools and upon the bottom of the streams. Sometimes the collections of these filaments have the appearance of frost work in the scalding hot water. Eventually the threads become cemented together by the continual deposition of lime, but they impress their individuality upon the resulting formation by giving it a fibrous structure. These points are well illustrated by the photograph of a piece of formation shown in Fig. 5.

The tufts of waxy bacterial filaments are often associated with extensive growths of quite a different character. Large areas upon the sides and bottoms of the pools and streams are frequently covered by a closely packed felt of extremely delicate filaments. The surface is smooth and slippery, and it feels like a sheet of rather stiff jelly all gritty because of the numerous crystals of calcium carbonate deposited in the substance. Under magnification the true structure is made apparent, and one sees here a closely woven mass of very minute filaments agglutinated together. The individual filaments are sometimes less than one-thousandth of a millimeter in diameter, so that they look like mere lines even under a magnification of 200 to 300 diameters. Fig. 6 illustrates the general appearance of

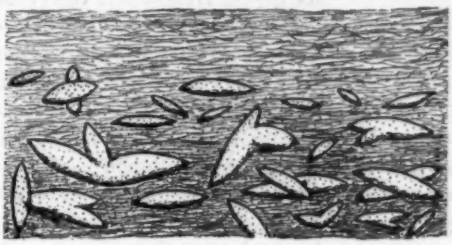

FIG. 6.

the leathery felt and shows the many crystals of calcium carbonate imbedded in the mass of filaments. The cells of this plant are several times longer than broad and the color is greenish. The genus is called *Phormidium* and contains forms closely related to a very common blue-green alga of stagnant waters, named *Oscillatoria*. There are several species of *Phormidium* in the hot springs, differing from one another chiefly in the measurement of the cells. The smallest forms, such as are shown in Fig. 4–c, are found in water as hot as 75° C., while the larger types (Fig. 4–d) only inhabit water that is several degrees cooler. The color of the *Phormidium* growths is quite variable. When actively vegetative the tint is bright green, but older sheets become brownish and the presence of various mineral deposits give the growths shades of golden yellow and dark red. If dried in the sun the colors fade out through various tints of yellow and pink to the everlasting white of the formation.

Another interesting plant frequently makes itself prominent, side by side, with the *Phormidium*. It is called *Spirulina* and, as the name suggests and the figures (Fig. 4–e) show, the form is a filament closely coiled in a spiral. This organism has the power of forward movement, the free ends swinging from side to side in such a man-

ner that the delicate thread travels over its substratum and among other algæ. *Spirulina* mixed with *Phormidium* often forms curious raised rims about the pools of hot water. This phenomenon is especially well shown upon the edge of the Prismatic Spring in the Middle Geyser Basin, also known under the more picturesque name of Hell's Half Acre. The Prismatic Spring is an immense pool of hot water about a hundred yards wide. The center of the spring is of a dark blue color, which gradually changes through shades of green to a light yellow around the margin, where the water is shallow over the sloping bottom of the basin. On the edge of the pool is a greenish growth variegated with brown and yellow. It has the form of a rim several inches wide raised above the mineral substratum and acting as a slight obstruction to the ripples of hot water that constantly splash over it upon the formation. The substance of the growth is rather firm like wet felt, and the surface, figured with raised lines, resembles tripe. The masses of wet algæ are so warm that one cannot hold them, and the water that laps the edges of the deposit is much too hot to approach with safety. It is in situations such as these that the algæ of thermal springs play an important part in moulding the form of the mineral deposits, but this is a subject that will engage our attention later on in the paper.

We have now considered the organisms that are most characteristic of the hot water of the thermal springs. It is altogether probable that careful studies on the spot would bring out many interesting facts in respect to the number of species, and the precise range of their distribution through the various springs in relation to the temperature and character of the water. It is an interesting field for study, and deserves the attention of a botanist for three months, instead of three days, which the writer once spent in the Geyser Basin.

As the water grows cooler in the overflow streams the conditions gradually become suitable for types more familiar to the botanist. A species of *Anabæna* (Fig. 4–f) is prominent in some places, and members of the Chlorophyceæ and diatoms are found, but these types are not truly a part of the flora of the thermal springs.

One more form deserves notice from the peculiarity of its structure and the curious situations in which it is found. There are places in the Geyser Basins and on the deposits of Mammoth Hot Springs where steam issues from the cracks and crevices of the formation. One may frequently find the mineral matter in these openings colored a bright green by a delicate film of slime. This is largely made up of *Glœocapsa* (Fig. 4–g), a unicellular alga that is characterized by the presence of very thick cell walls made up of concentric layers, the outer becoming gelatinous. These slimy films must be kept continually damp by the hot steam that issues from the vents.

The inhabitants of the thermal springs are all members of one or two families of plants, and a greater interest attaches to them because the fact is plain that the conditions under which they live are not suitable for the forms of algæ that commonly crowd our ponds and streams. In a general way they are all closely related to one another. The colored forms are all members of the class Cyanophyceæ, the lowest group of the algæ, and the colorless type all belong to the class Schizomycetes, or bacteria, the lowest group of the fungi. Moreover, the forms of Cyanophyceæ and Schizomycetes are quite generally considered to be near relatives. Indeed, all the members of both groups have been classified under one name by some authors and called Schizophytes, which means plants that split. All the forms agree in having a very simple

cell structure. Until quite recently investigators have been unable to find any indication of that organization of the protoplasm into a nucleus and chromatophore, such as is present in the ordinary plant cell. Now botanists are able to distinguish nuclear matter in the cells of some of the larger types, but it is found in a scattered form with vague contours and never in the shape of a well-defined, compact structure. The phenomenon of cell division is here found in its simplest type and gives the name to this group of plants. The cell simply splits apart and there are two individuals where formerly there was one. The cells may remain attached to one another and so form filaments of considerable length, but each cell is probably physiologically quite independent of its neighbors. The facts plainly indicate that the protoplasm of these types is not as highly organized as that of more complex forms of plants; probably they are able to withstand these unusually high temperatures because of this low grade of protoplasmic organization. Perhaps, but this does not necessarily follow, these organisms resemble more closely the primitive first forms of life than any other living types. One would like to know about the precise conditions governing the lives of these simple cells and something of their past history. It is possible that they may have crept into the hot springs from the colder water, or perhaps their ancestors may have always lived under the infernal conditions which now surround them. A very thorough study of various pools and streams at different temperatures might solve the problem. The field of study is as interesting as it is difficult.

Now let us examine these organisms in their rôle as geological agents or factors influencing the deposition and shape of the formation. We must remember that the formations are of two sorts: first, the calcium carbonate deposits illustrated most strikingly by the immense pile at Mammoth Hot Springs; and second, the silicious formations of the geyser basins. Calcium carbonate ($CaCO_3$), the substance which makes up the chief part of all limestone and marble, of coral and most shells, is practically insoluble in pure water. However, water charged with carbon dioxide (CO_2) dissolves calcium carbonate, and it is pretty generally believed that the latter passes over to a new substance, calcium bi-carbonate with the formula $Ca(HCO_3)_2$. But calcium bi-carbonate is not known in a solid crystalline form because, when water containing it in solution is allowed to stand exposed, the carbon dioxide escapes and the usual calcium carbonate immediately separates out from the solution.

The water that issues from the formation on the terraces of Mammoth Hot Springs has been under pressure and is highly charged with carbon di-oxide. It holds an unusually large amount of calcium carbonate in solution, a fact for which the bed of Mesozoic limestone, through which the boiling hot water passes on its way to the surface, is responsible. When the water emerges from the orifices of the hot springs and spreads out in the shallow streams and pools there is an immediate escape of carbon di-oxide from the supersaturated solution. The insoluble calcium carbonate is then thrown down as the dazzling white deposits of travertine. One may see the results of this property of the hot water illustrated by the absurd incrusted baskets, pine cones and horseshoes that are on sale at the hotels. This phenomenon is, of course, in no way connected with the activity of the organisms, and there is no question but that travertine would form and terraces would be built up even if no plant life were present in the water.

But the plant life undoubtedly hastens the deposition of calcium carbonate in the

following manner. The green plants require carbon di-oxide for the processes of assimilation and they take it from the water, which means, in this case, the deposition of a certain amount of calcium carbonate. There are many plants that have the power of taking calcium carbonate from water. *Chara*, the stone-wort, the marine algæ called Corallines, forms of the group Siphoneæ inhabiting the coral sands of Burmuda and Florida, are examples, and besides these there are species of Cyanophyceæ closely related to the forms actually found in these hot springs. If the tufts and felts be teased out, one may find innumerable crystals of calcium carbonate, varying in size, held in the meshes of the filaments. We have tried to show the appearance of such a preparation in Fig. 6. One may observe this very significant fact that the crystals at the bottoms of the tufts and sheets of algæ are large, and there are places where they have become cemented together into flakes of mineral deposits. In the middle region and towards the surface of the felts the crystals are small and scattered. It is evident that these expanses of algal growth lay down sheets of calcium carbonate and that the tufts build up little mounds upon the generally smooth surface.

It is altogether probable that the mineral deposits follow the development of the algæ very closely and actually entomb the older filaments at the bottom of the growths in limestone crypts. It is interesting to know that the first travertine thrown down in these waters is probably associated with the vegetation at the time of the deposit. We say probably because the fact cannot be proved in these hot springs, but we can reason from analogy, for the conditions here are quite similar to those of the waters of Carlsbad, in Germany. There the springs issue from granite rocks and the travertine is not deposited until traces of vegetation appear in the water. These interesting observations were made by Ferdinand Cohn. As all the streams of Mammoth Hot Springs issue from travertine deposits, it is impossible to tell exactly where the deposition first begins.

However important these algæ may be in their rôle as rock-formers, a greater interest attaches to them because most of the beautiful sculpturing and coloring of Mammoth Hot Springs is directly due to their presence. The rims on the pulpit basins (see Fig. 7) are covered with a growth of algæ. The interiors of the basins are lined with sheets of green and yellow on a white background, but it is the outside of the basins that exhibits the most beauty. There are pillars and flutings and stalactite-like structures all colored brown and orange and green. The algæ are responsible for almost all these peculiarities. If they were not present the water would flow in shallow sheets and fresh deposits of calcium carbonate would be laid down like so many coats of whitewash with unrelieved monotony.

But the algæ change the conditions. Here they grow in ropey welts down the sides of the pulpits from the lips of the basins; there they have formed a raised rim upon some flat surface and partially dam up some small pool or stream of water. Here they hang down from some projecting ridge as a slight fringe that drips water. Everywhere the growth of vegetation is but a thin veneer over a skeleton of mineral deposits that follows closely the lines of the algal sheet. The filaments project from a granular and gritty deposit enveloping the fibers that are not so fortunate as to be at the immediate surface. Consequently when, for some reason, the water ceases to flow over a certain part of the formation, and the colored vegetation dries up and entirely fades out in the fierce glare

of the sun, there is still left the form of the growth in raised relief upon the travertine.

In the shallow pools, only a few inches deep, one may find the most delicate frostwork creeping in from the side. Here the algal network is a skeleton upon which is laid a coating of calcium carbonate in the form of delicate granules. The filaments frequently have a beaded appearance, somewhat similar to cobwebs covered with minute drops of dew. The effects are particularly striking when a stream of water suddenly spreads out over a flat surface. Then the frosted growths radiate out from a common point and the effect is sufficiently prominent to give rise to the term 'fan' that is applied to such figures. Of course, the more delicate patterns upon the formation are not lasting. The wear and tear of the summer tourist season, and the freeze-up in the winter, break the lace work, but it is quickly renewed every spring. Indeed, there is opportunity for the exhibition of taste in the judicious distribution of the hot streams over the older portions of the formation. They could readily be kept in repair, for fresh deposits are laid down with astonishing rapidity.

We now pass to the consideration of the silicious formations of the geyser basin and here we encounter some peculiar problems. The water comes forth boiling hot and supersaturated with silicious matter. There is no question but what some of this must be thrown down from the solution as the water cools. Indeed, one may sometimes find soft deposits of a gelatinous nature around the vents of various springs and geysers, apparently thrown out by a sudden discharge. Evaporation alone would make possible the gradual building-up of the interesting cones around the orifices of geysers. However, the deposition as a rule must go on very slowly, and the calculation has been made that in certain instances not more than one-sixteenth of an inch is deposited each year.

But our problems are concerned with the beautiful transparent pools scattered over the formation. Their water is as clear as crystal and the mineral matter on the sloping sides is as firm and hard as chalcedony. There is no vegetation in the hottest of these pools, but where the water has cooled down a few degrees one may find abundant growths of algæ. There are membranous patches of various shades of green and masses of yellowish jelly and also tufts of very delicate filaments that hold many bubbles of gas entangled in their meshes, making them rise up like small balloons held down by numerous cords. There are many peculiarities about these pools that make them very interesting. The sides are frequently moulded into curious figures, giving reasons for such names as 'The Oak-leaf Spring,' 'The Aquarium,' etc.

But the most peculiar structures are pillars that stand up from the bottom of the basin. They are of various sizes, some merely slight cones that roughen the stony floor of the pools, others finger-like projections. In its fully developed state the column rises to the surface of the water. As it grows older it becomes gradually thicker until the mass of deposit resembles a small island in a miniature sea of hot water. Fig. 7 shows one of these shallow pools from which the water had been drained. There are many columns, large and small, present in this instance, and the figure illustrates a characteristic peculiarity, namely: that often the top of a pillar spreads out at the surface of the water in a form that resembles the umbrella-like top of a toadstool.

How are these columns and the figures in raised relief formed? Have they any connection with the algal vegetation? Indirectly there is a very important relation. It is not probable that these algæ secrete

silica. There are comparatively few plants that have this power and among the algæ the forms called diatoms are the only examples. They are not found in these hot pools. The writer has never heard that any member of the Cyanophyceæ has this power, and the specimens that he has examined from the hot springs gave no evidence that silicious matter was secreted directly around the fibers, for the deposits were in the form of granules of amorphous silica distributed among the filaments. It is a principle well known to the physicist that matter in solution is often far more likely to be thrown down when foreign bodies are in the fluid. The mere presence of such material offers surface or otherwise disturbs the equilibrium and hastens the appropriate physical changes. Thus the phenomenon of crystallization will take place much more quickly and completely from a solution if there be strings or other

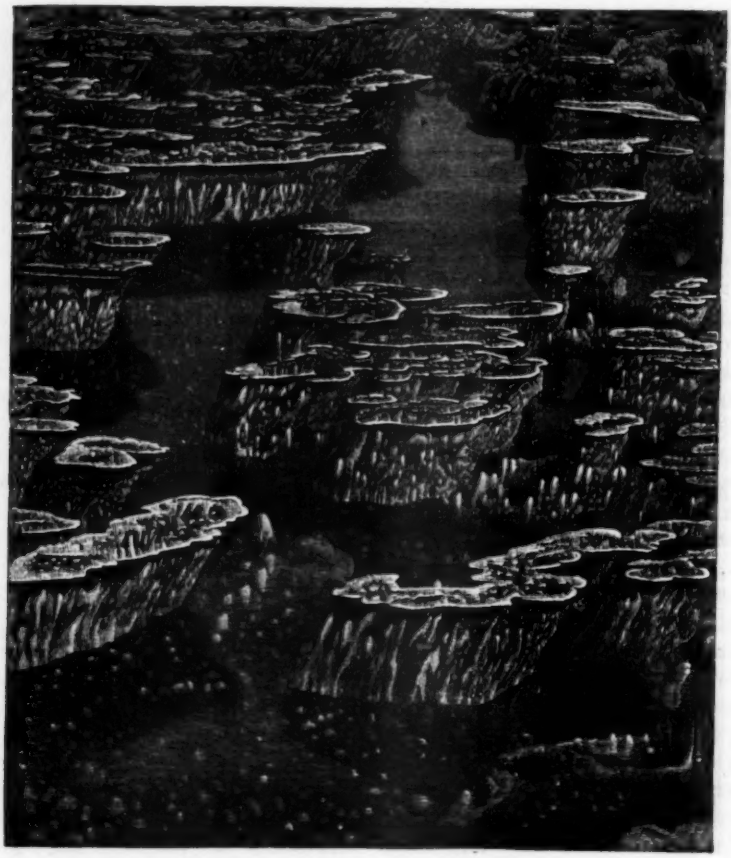

Fig. 7.

bodies present upon which the crystals may form.

It seems probable that in these facts we have an explanation of the influence which vegetation appears to have upon the deposit of silicious material in the pools of the geyser basins. The mere presence of the algal filaments as foreign bodies encourages the deposition of silica, and it naturally follows that the greatest amount of silica is thrown down where the vegetation is thickest. This gives us the entire secret of the peculiarities of columns and mouldings. As has been before described, it is the habit of algæ in quiet water to grow up in tufts. A tuft once established leads to the deposition of more silica at that particular spot, and soon there will be formed a little mound or cone, capped and covered by a mass of filament. The algal filaments always tend to grow upward in quiet water, if for no other reason because of the numerous bubbles of oxygen thrown off, which, becoming entangled in the threads, tend to buoy them up. As the algal cap on top of a cone grows upward, more silica is laid down at its base, and so a column of deposit gradually rises. When the cap of vegetation reaches the surface of the water, there is, after the habit of such forms, an immediate radiation of the filaments in all directions. Consequently, when the final deposit of silica is left upon the top of the column, it extends on all sides as an overhanging capital. As the shaft of the pillar is covered with the sheet of vegetation, we can readily understand why it should thicken and why there might be irregular protuberances or even smaller columns rising at different levels along the sides of the larger. Of course, the algal growth will not be uniform on all sides of the pillars, any spot that is especially vigorous leaving a record for itself through a larger amount of mineral deposit.

Much more must be known about the exact conditions of growth in these thermal waters, before the many peculiarities of the mineral deposits are explained. But a new interest is added to the hot springs of Yellowstone Park and their deposits when one thinks of the parts these simple organisms play in the construction.

Children of steam and scalded rock, a story you have to tell,
Writ in the glare of sunshine bright,
Sculptured and etched in marble white,
Illuminated in colors bold,
Richer than ever parchment old,
Children of steam and scalded rock, what is the story you have to tell?

Our legends are old, of greater age than the mountains round about.
We have kept our secrets epochs long,
They are not to be read by the passing throng.
It is nothing to us what men may say.
If they wish our story the price they must pay
In hard brain work, ere the tales are told. We challenge mankind to draw them out.

Children of steam and scalded rock, your challenge must rest for the present age.
I have scarcely broken the outer crust
That covers the greater truth, but I trust
Some man will follow and therein find
Knowledge, that to the Present shall bind
The Past with cords wherein entwine
Threads of the perfect truth, divine.
Children of steam and scalded rock, some man to come will accept thy gage.

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RAREFIED AND CONDENSED AIR.

AFTER reading Paul Guessfeldt's enthusiastic description of 'mountain-ecstasy,' as he calls it, which the rarefied air of high altitudes produces and which he describes as consisting of 'an increased sense of joy caused by an increased muscular activity, and a wonderful buoyancy of the feelings which at moments rises to ecstasy,' we are tempted to follow him to those heights in order to experience these feelings which can be so easily obtained with a little physical exertion.

A different point of view is presented to us by D'Orbigny (1826) in an account of the sensations he experienced while crossing the highest pass of the Cordillera in Bolivia, which is 4,500 meters (about 15,600 ft.) high, on his way from the coast of Peru to La Paz. For several days before reaching the highest part respiration was difficult. His driver, the mule he was riding and his dog suffered so much that they were compelled to halt every 20 or 30 meters to regain their breath. While crossing the crest of the ridge he suffered intensely from pains in the temples, vertigo, and extreme difficulty in breathing. Every movement of the body produced palpitation of the heart, followed by a feeling of general debility, until bleeding of the nose finally relieved him. During this attack of 'mountain-sickness' he saw two natives, who had overtaken him, hurry on their way, climbing the rocks with the greatest ease.

It is evident that D'Orbigny did not belong to an Alpine club, and did not have the necessary training, or else he would not have suffered so intensely at an altitude which has no effect upon those who now ascend Mount Blanc.

A man who has had no practice in mountain climbing is apt to experience sensations similar to those which D'Orbigny described, while yet under the ordinary atmospheric pressure. For instance, in hurrying up a steep incline, say in the winter, when you sink into the snow with every step, you will very likely become short of breath, since the rapid climb prevents the full expansion of the lungs. This disturbs the circulation of the blood, which, being no longer freely admitted into the contracted lungs, collects in the veins. They swell up, the face becomes purple, the pulse-beats are accelerated, and palpitation of the heart sets in. In case the exertion is continued, an attack of nausea is imminent, together with a feeling of faintness in the lower limbs, as the overworked muscles are deprived of their requisite supply of oxygen. A few long drawn breaths usually suffice to remedy the disorder. By gradually becoming accustomed to walking and breathing slowly and regularly a further attack is prevented.

These symptoms, as they manifest themselves in the rarefied air of high altitudes, constitute what is known as mountain-sickness, and persons unaccustomed to mountain-climbing are frequently affected by it even while resting or when not exerting themselves. Here, again, the cause of the disorder is the insufficient expansion of the lungs, caused by the diminished atmospheric pressure which renders respiration difficult.

But, it may be objected that the energy with which we inhale the air is the same at high altitudes as below, and the rarefied air ought to penetrate into the lungs more easily. This is perhaps true, but, although we expand the chest during inhalation, the expansion of the lungs is only accomplished by means of the atmospheric pressure. The lungs are not attached to the inner surfaces of the thorax and can move freely. A wound in the thorax which admits the passage of air causes the lungs to contract, and all the exertions of the breathing apparatus will be powerless toward relieving this contraction.

As long, however, as the cavity of the chest remains closed and contains no air, the pressure of the air in the lungs acts from within outwardly and by expanding the lungs will cause them to remain in contact with the sides of the chest as it expands during the process of inhalation. The ease with which the lungs are expanded depends upon the amount of atmospheric pressure which is brought to bear upon their elastic power of resistance, and this action consequently becomes more difficult as the lighter pressure of higher altitudes is reached. Let

us suppose that the usual pressure is reduced to one-half, then the rapidity with which the lungs are expanded, although still greater than the usual rate of the chest expansion, is yet only half as rapid as when under the customary atmospheric pressure, and under certain circumstances this may seriously disturb inhalation.

Exhalation, on the contrary, is accelerated by the lighter pressure of a rarefied atmosphere. It generally takes place without the aid of the muscles which assist in the process of inhalation. The expanded parts, as the lungs, diaphragm, etc., contract to their original size and position by reason of their elasticity, as soon as the muscular force which was applied during inhalation is relaxed. The employment of the abdominal and intercostal muscles as an aid to exhalation is exceptional.

The only obstacle which retards the contraction of the lungs is the pressure of the outer air, which resists the outflow of the air from the windpipe and is diminished as the atmosphere becomes rarefied. Consequently the contraction of the lungs is greater and more rapid in a rarefied atmosphere. Exhalation is, therefore, in general, a mechanical process, and as such is subject to a certain law acording to which it can be performed on the summit of Mount Blanc in $\frac{8}{10}$ of the time required under the ordinary atmospheric pressure.

Humboldt tells us that newcomers in the vicinity of Quito, Ecuador, where the altitude is between 2,600 and 3,600 meters (11,800 ft.), have considerable difficulty in breathing, especially when talking rapidly. This is explained by the fact that the supply of breath usually reserved for the formation of sound escapes more rapidly and is therefore sooner expended. It has also been observed that some persons are unable to whistle where the pressure has only been diminished from 760 mm. (ordinary atmospheric pressure) to 500 mm. The whistling sound is produced by placing the lips in a certain position, and depends upon the rapidity with which the air is forced out of the lungs by means of the abdominal muscles. Naturally, the amount of muscular force so expended is still suited to the requirements of the denser air to which one has been accustomed. As the atmospheric pressure is diminished, the air escapes more rapidly and the expected sound is not formed. In order to learn again how to whistle, it is necessary to place the lips in another position and to apply the muscular force differently, which always requires considerable time and practice.

Physicians who have made a short stay at Davos, which lies at an altitude of only 1,600 meters (5,200 feet), state that during that time their respiration was much accelerated, while there was an inability to breathe deeply. The explanation of this phenomenon is the diminished atmospheric pressure which also causes an acceleration of the pulse-beats—the inevitable result of insufficient lung-expansion. Accelerated breathing at high altitudes affects metabolism by aiding in the removal of gaseous excretions, such as carbon dioxide.

Aëronauts observed the acceleration of the pulse to be the first physiological change. They can reach a much higher altitude than mountain climbers without having any difficulty in sustaining respiration, as their muscular exertion is not so great. But the transition to the rarefied air is more sudden, and the increased, difficulty in breathing, which now appears although the aëronaut is generally unconscious of it at first, results from an insufficient expansion of the respiratory organs, which renders them incapable of admitting the requisite amount of rarefied oxygen. The strength of his respiratory muscles is diminished; he finally loses control of his limbs, and his senses are dulled. This

was the experience of Eroce Spinelli, Sivel and Tissandier, who, on August 15, 1875, reached an altitude of 7,000 m. (23,750 ft.) with an atmospheric pressure of only 300 mm. in two hours. They followed Paul Bert's advice and inhaled oxygenated air, as a result of which their strength immediately revived.

After a longer sojourn in regions of high altitude the symptoms of mountain-sickness pass away, as respiration is gradually regulated to suit the conditions of the rarefied atmosphere. The change which this necessitates is easily explained. In order to breathe deeply it is necessary to expand the lungs more slowly, and this is only accomplished by means of continuous unconscious practice which strengthens the respiratory muscles. The members of Alpine clubs who make high ascents keep in practice by repeating their excursions frequently. Hence they are far less subject to mountain-sickness than those who have had no previous training.

The wonderful feats of Paul Guessfeldt, which are described in the German Rundschau of 1892, are a good illustration of the benefits to be derived from such a training. He breathed and moved without any inconvenience at an altitude of about 5,500 meters, where the atmospheric pressure is equal to only one-half of the ordinary pressure. In ascending Mt. Aconcagua, in Chile, he had no difficulty in breathing until after the altitude of 6,000 meters had been reached, and even then he was finally able to ascend to the summit, which has an elevation of nearly 7,000 meters, or 23,910 ft., an altitude at which aëronauts are compelled to have recourse to their supply of oxygenated air.

A distinguishing characteristic of the air of high altitudes as compared with that of lower regions is its freedom from moisture. The atmosphere is so dry on the plateaus of the Andes in Peru and Bolivia, where the altitude ranges from 3,600 to 3,900 meters, that the flesh of butchered cattle can be dried in the open air. The two explorers, D'Orbigny and Wedell, both report that the sheep which are killed there are split open and salted, after which they are hung up in the open air, and are dried in four or six days.

The ocean is the chief source of the moisture contained in the atmosphere; consequently the interior of the continents is drier than the coast regions, and in the same way the moisture decreases as we rise above sea level. The lower stratum of air up to about 2,000 meters (6,500 ft.) contains one-half of the whole amount of aqueous vapor in the atmosphere, and here the cloud-formations are densest and most frequent, while above this altitude the sky is much clearer.

It is a well-known fact that extreme dryness of the atmosphere stimulates the nervous system, making one feel brighter and more inclined for both physical and mental activity. The inhabitants of very dry regions, according to the reports of explorers, are free from any tendency to obesity.

In trying to escape from the hot air of the cities in the summer we look for a place which is situated higher above sea level, because we know it to be cooler. In the torrid zone, resorts with an elevation of from 2,000 to 3,000 m. are popular. In spite of being nearer to the sun, the air is cooler, as the sun's rays have practically no effect upon it. The air allows the rays to pass through it freely, but receives its warmth from the dark heat rays which are reflected from the earth after the sun has warmed it. The lower strata of air are, therefore, always warmer than the upper. But the plateaus of the highlands are cooler too, as well as the summits and crests, for their rarefied atmosphere is incapable of absorbing as much of the heat reflected by the earth as the denser atmosphere of the

lowlands. Although the surface of the earth receives more heat at high elevations, it is immediately reflected back into space without heating the air to a corresponding degree. This is evidenced by the fact that at high altitudes the difference of the temperature in the sun and in the shade is greater than in the lowlands. But the effect of the sun's rays is felt more keenly at a high elevation, so much so that persons staying at Davos can enjoy a sun-bath in a sheltered spot even in the cold of winter, although wearing much thinner clothing than at home.

It takes a visitor at Cerro de Pasco, in Peru, which lies at an elevation of 4,500 meters, ten or twelve days to thoroughly regulate his respiration to the conditions of the atmosphere. In case his suffering is greater at first, it often happens that he is compelled to make a temporary change of residence to a point some 1,000 meters nearer the level of the sea. Even during the descent he begins to breathe more easily and feels brighter and stronger.

The inhalation of air which has been artificially condensed, as in a pneumatic cabinet, produces quite similar sensations. An asthmatic patient placed in an atmosphere where the pressure has been augmented by nearly one-half will immediately be enabled to breathe more freely; respiration becomes slower; his excited nerves are quieted, and he feels imbued with renewed vigor.

The mechanical action of condensed air as it affects respiration is the reverse of the action which takes place in rarefied air. A higher atmospheric pressure facilitates the expansion of the lungs, and the condensed atmosphere, by delaying the egress of the air expelled during exhalation, finally effectuates a distended condition of the lungs. The pulse-beats become slower at the same time, and the veins, which were surcharged with blood under a diminished pressure, are now emptied more thoroughly. This is the cause of the decrease of congestive conditions in a pneumatic cabinet. The amount of oxygen which we inhale is increased in proportion to the increased condensation of the atmosphere, thereby enriching the blood. If the treatment is continued, this soon makes itself manifest by an increased appetite and a healthier complexion. The invalid gains in strength and vitality. Respiration is facilitated even outside of the cabinet, and by such observations we perceive that the employment of condensed air has after-effects, which supposition the spirometer confirms. A deeper and more quiet respiration has been observed in some cases after the elapse of one and even two years.

The air which is admitted into the pneumatic cabinets by means of air pumps can be kept at any degree of condensation. The cabinets, which are of various sizes, are arranged to admit from three to fourteen persons, and naturally great care is taken to have a good ventilation. They generally stand in the center of a lighted hall; their walls are composed of sheet iron and provided with windows which admit ample light for reading. The cabinets are used exclusively for the cure of catarrhal diseases, to facilitate the respiration of asthmatic patients, and to improve the condition of the blood of anæmic persons, in which cases the condensed air frequently proves beneficial after all other remedies have failed.

The first pneumatic cabinet was established somewhere in the thirties, at Montpellier, by a physicist named Tabarie, who later gave the management of it into the hands of a physician. Pravaz soon followed his example at Lyons, and the reports of the two scientists as to their observations made on healthy and diseased persons were presented before the French Academy and to the medical world in quick succession.

About thirty years later the idea of putting condensed air to this use spread from France to other countries of Europe, and the largest institution of this kind at present is at Reichenhall, the property of E. Mack, in which 53 persons can make use of the heightened pressure at the same time.

In 1841 M. Triger, a civil engineer, introduced in France the idea of using a heightened atmospheric pressure in building sub-aqueous works, and this gave an opportunity to observe what effect an atmospheric pressure which was much higher than that of a pneumatic cabinet would have upon the workmen. The work under pressure is carried on in an iron shaft, the sides and top of which are air-tight. It is sunk to the bottom, like a diving-bell, while the upper end protrudes above the surface of the water. The fresh air which is continuously pumped in from above expels the water below, leaving the bottom free to be worked upon. The shaft sinks deeper and deeper as the earth is removed, until there may be a pressure of $3\frac{1}{2}$ or nearly 4 atmospheres. A pressure of ten meters of water is equal to about one atmospheric pressure.

The effect of the condensed air upon the laborers was found to be surprisingly favorable up to a pressure of two atmospheres. The hard work was accomplished more easily and with less fatigue than in the open air, and in such exertions as running up a ladder they did not get out of breath. Even after working hours the men felt stronger and in better spirits.

But when the pressure exceeds that of two atmospheres the men begin to have certain unpleasant sensations, such as itching and pains and swelling of those muscles which are strained the most. These symptoms do not, however, appear while under the heightened pressure, but make themselves felt during the time that the men are under the normal pressure, and pass away again as they return to their work. The overseers are exempt from these effects. They receive instead a mental stimulus which is manifested by an increased impulse to talk.

If the atmospheric pressure is still further increased, the resistance against exhalation becomes stronger. The action of the respiratory apparatus is weakened by the increased distension of the lungs until it finally becomes almost imperceptible; speech is difficult, and whistling impossible. The result of the too rapid contraction of the lungs under a diminished pressure which prevents whistling is the same as that which follows when the egress of the air expelled by the lungs is delayed.

The enlivening influence on the workmen is diminished as soon as the pressure exceeds that of three atmospheres. The slow and imperfect performance of the respiratory function begins to have a detrimental effect upon the gaseous interchange which takes place in the lungs by causing the carbon dioxide to be retained in the blood. The laborers become more easily fatigued, and a decrease of appetite is followed by loss of flesh, if they continue the work. We find, therefore, that there is a limit to the condensation of air which a man cannot overstep without detriment to himself, but there is a wider limit in this direction than in that of rarefied air.

Experience proves that a temporary change from the normal pressure to an increased or diminished pressure is pleasant and also benefits vitality in various ways. We are able to ascend to any altitude at which the air is rarefied to the desired degree, but the privilege of choosing a denser atmosphere in which to live is denied us. It is only from a few places at very high elevations that convalescents can be sent down to a lower altitude where they quickly recover by inhaling air which is more condensed and contains a larger proportion of oxygen. The inhabitants of the

lowlands are confined to the pneumatic cabinet in their search for these benefits. From what has been said regarding the mechanical change which respiration undergoes we gather that a temporary employment of condensed air, besides its various other effects, would be a good preparation for the proper performance of the respiratory function in a more rarefied atmosphere.*

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NOTES ON THE NATURAL HISTORY OF THE WILMINGTON REGION.

A BRIEF collecting trip to the vicinity of Wilmington, N. C., made about the middle of April, greatly impressed me with the natural history advantages of the region. I publish these few notes in the hope that they may be of service to other naturalists who think of visiting the Southern coast.

In Wilmington itself no one can fail to notice the admirable shade tree, the laurel oak (*Quercus laurifolia* Michx.), so common along the streets. This tree in Wilmington passes under the name of water oak; in South Carolina it is known as the Darlington oak. Its straight bole, symmetrical top and moderate size give it an elegance of shape well suited to city streets, and the impression of finish is heightened by the glossy aspect of the foliage.

From the city there runs a most excellent road, eight miles long, to Wrightsville, a settlement on the coast. The road is a well-kept shell road, smooth, hard, and good for bicycling. Scrub oaks, elms, long-leaf pines and cypresses edge it, and near the sound the full green heads of the live oaks are seen on all sides. In the open meadow-like places (savannahs) to the right and left of the road there grow in great abundance insectivorous plants, the most interesting members, to the general biologist at least, of that rich Wilmington flora made known through the labors of Curtis, Wood and other systematic botanists. The yellow-flowered pitcher plant, *Sarracenia flava*, dots the savannahs in all directions; its great flower (four inches wide) upheld by a scape one to two feet, making it a conspicuous object. The fly-trap, *Dionæa*, and sun-dew, *Drosera*, neither in flower at the time of my visit, are scattered thickly about. Intermingled with these are a blue and yellow species of butterwort, *Pinguicula*, their bright flowers standing out clearly against the (at this time) brownish savannah and often leading one to patches of *Dionæa* and *Drosera*, which otherwise would have been passed by unnoticed. These five insectivorous plants may sometimes be found growing together in a little patch of ground, scarcely larger than a square foot.

The topography of the Wrightsville district is that characteristic of the Carolina coast, and in a less degree of the Southern coast in general. A sound separates the mainland from a seaward strip of land, known as the 'banks.' Wrightsville, largely made up of houses occupied only during the summer, is on the mainland. Opposite it, on the banks, is a newer summer settlement. Between the two, the sound is crossed by a railroad trestle, the piles of which afford good collecting.

The sound something less than two miles wide, is divided into a narrow outer portion, adjoining the banks and known as the banks channel, and a wider inner portion, studded with sandy-mud shoals. The banks channel is a narrow but pretty boating ground, opening out to sea through two inlets, one recently made in a heavy storm. Along the inner edge of the channel lie some islands, the 'hammocks,' wooded with live oaks, about which jackdaws (*Quiscalus major*) were flying. This bird is said to spend the winter here.

*Translated from the author's MS. by Henriette Weber, Columbus, O.

At high water one can sail over many of the shoals of the inner part of the sound, but at low water the course from the mainland to the banks channel is a meandering one. The shoals are alive with worms, *Arenicola*, *Diopatra*, *Clymenella* and other annelids, along with the great *Balanoglossus*, were dug up in quick succession. The reddish egg masses of *Arenicola* lay about in abundance on the flats. The low water collecting in the shoal part of the sound is very easy. Pushing along in a skiff through the shallow channels between the flats, one finds starfish (*Asterias*), the red and white sea-urchins (*Arbacia* and *Toxopneustes*), abundant crabs and other common bottom forms. Scattered about over the bottom in great numbers is the interesting anemone, *Cerianthus americanus*. The tubes that were dug up were something over a foot in length; they contained animals, which of course had greatly contracted, about six inches long. This distinctively Southern actinia, originally found on the South Carolina coast by Professor Louis Agassiz (Verrill, Revision of the Polypi of E. Coast of U. S., p. 32. Mem. Boston Soc. Nat. Hist., Vol. I.), has been observed by Mr. Wm. Stimpson and Professor McMurrich at Beaufort, N. C., where I have seen it myself. It is, however, far more abundant at Wrightsville, and any one wishing to work out the life-history of this remarkable form could find no better locality than the latter place. I may add that the reproductive organs of the specimens I collected were very small. The breeding season probably comes on later.

Just before high water I towed in the neighborhood of the old inlet. As I had anticipated from previous experiences in Beaufort harbor at this time of year, not much of interest was in the water. Small hydromedusæ, crustacean larvæ, abundant *Sagittas*, make up the tow stuff. Later in the year, doubtless as at Beaufort, the towing is excellent. I am told that abundant large jelly-fish and Portuguese men-of-war make their appearance in August and September.

The sea-beach has a very gentle slope, and judging in part from specimens sent me by Mr. Chas. M. Whitlock, of Wilmington, many things of interest are to be had just beyond the line of breakers, where the sea is frequently calm enough to permit collecting. In the main the Wrightsville fauna is evidently very similar to that of Beaufort (see the lists in Studies of Biol. Lab. Johns Hopkins Univ., Vol. IV., No. 2, and the list of annelids by Professor Andrews, Proc. U. S. Nat. Mus. Vol. XIV., No. 852). I may add that some of the local collectors would recognize, from a description, many of the striking forms, such as *Chætopterus*, *Chalina arbuscula*, *Leptogorgia virgulata*, all of which may be had here.

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CURRENT NOTES ON ANTHROPOLOGY.

Petrie's 'New Race' in Egypt.

Two years ago (Science, August 28, 1895) I described the discovery by Mr. Flinders Petrie in Middle Egypt of remains which he attributed to an invading race about the twelfth dynasty, and which he was inclined to believe were Libyan stock.

Since then there has been considerable discussion of the subject, the general trend of which was in favor of Petrie's view. Dr. G. Schweinfurth, however, in the *Verhandlungen* of the Berlin Anthropological Society for January, attacks this theory, and claims that the remarkable stone artefacts unearthed in the tombs of the 'New Race' are such as are made to-day by the Ababde in the Thebaïs. He is inclined to the belief that the ancestors of these tribes in prehistoric times were the so-called 'New Race' and came from the Bedcha stock, near the coast of the Red Sea.

There are, however, a number of facts overlooked by Schweinfurth which indicate that the 'New Race' were conquerors of an older Egyptian civilization; nor is it likely that the Bedchas would have occupied so exclusively the left bank of the Nile, when their homes were east of its right bank. Petrie's supposition is still the most probable of any offered.

A PHILOSOPHIC SECT.

IN the May number of the *Journal of the Anthropological Institute*, Mr. H. Balfour describes the sect of the Aghori fakirs in India. Their doctrine and their practice are based on the philosophic principle of the fundamental equality of all things, and, therefore, they are sticklers for absolute indifferentism. They disregard caste and creed, and receive accessions from the votaries of all religions. They are mendicants and despise property and labor. They eat with indifference carrion, offal or excrement, and as a cup or dish they use a fragment of a human skull, often quite fresh. In creed they are monotheists, believing in one god only, and have no respect for persons except the teacher or *guru*, who has initiated them into the sect. He gives each disciple a name, thus blotting out his past self.

It seems somewhat inconsistent that they should have a form of marriage, but other writers speak of their women as prostitutes. Originally, they seem to have been worshippers of Devi, the wife of Siva, in whose cult obscenity and bestiality were pushed to their furthest extremes.

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NOTES ON INORGANIC CHEMISTRY.

AN account is given in *Nature* of the meeting of the International Congress on Technical Education held in London, June 15th–17th. The opening day was devoted to the teaching of chemistry. In one paper Dr. Otto N. Witt, of the Polytechnic School of Berlin, said he could not admit any fundamental difference in the methods of research of pure and applied chemistry; consequently he could not admit the necessity for a difference of instruction for the two. A well-organized instruction in pure chemical science would be the best preparation of any young chemist for his future career. Schools for producing specialists are not wanted; specialism comes as a matter of course in later life. Chemists are needed who embrace their science as a whole, and who are incapable of separating either practice from theory or theory from practice. Dr. Gladstone, speaking of evening schools, said that when the school was situated in the neighborhood of factories it would be allowable and even desirable that the illustrations should be chosen with some reference to the prevailing industry. This is a principle capable of wider application.

IN a paper by Professor Lunge, of Zurich, the writer held that, to raise English chemical industry to the foremost rank, it is necessary that the technical management of chemical factories should not be left in the hands of 'rule-of-thumb' men, but should be entrusted to real chemists. These men should have a much fuller education than the majority of chemists seem to obtain at present in Great Britain, which means that they must spend more time and money on their training than they generally do. At college the student should receive a thorough training in scientific chemistry, taking this in its widest meaning, not merely as a 'testing' exercise. Next to this, but not to the same extent, he should be taught physics, mineralogy, technology, mechanics and the elements of engineering. Professor Lunge held that it was unwise for the common workmen or even the foremen to have a knowledge of chemistry or technology, as it is their duty

to simply carry out instructions, and not to meddle with the chemical process itself. Professor Silvanus P. Thompson, in discussing Professor Lunge's paper, urged that where a great industry is localized, science should be applied to that industry, and an institute should be put there devoted to monotechnical rather than polytechnical instruction. Training in research is absolutely necessary, and specific research should not be undertaken too soon by students who have not been taken through an all-round course in chemistry. Sir Henry Roscoe pointed out that England suffers chiefly from the failure of her manufacturers to see, as they ought to see, the importance of the highest scientific training for their employés. Scientific teaching has taken up a sound position already, and if manufacturers will only appreciate its value England can turn out scientific men as well as any country in the world.

THE last *Berichte* of the German Chemical Society contains a series of observations of the amount of carbon dioxid in the air of Sheffield, by W. Carleton Williams. The mean amount found in 142 determinations in the suburbs is 3.266 parts per 10,000, the maximum being 5.14 and the minimum 2.16. The average of 22 determinations in the center of the city is 3.9, with a maximum of 6.22 and a minimum of 2.80. These figures are higher than those observed in Paris (2.85), Dieppe (2.94) and Odessa (3.04), and only equaled by those in Dundee (3.9). As regards the conditions pertaining at the time of the experiment the following conclusions are drawn. During mist and snow the amount is increased; no difference is shown in rainy weather (previous observations on this point differ); a maximum (3.6) is reached in January, decreasing to a minimum (2.59) in April; the amount decreases with the increase of temperature—below 0°, 4.06; 0°–5°, 3.31; 5°–10°, 3.22; 10°–15°, 2.98—possibly due to increased fuel consumption in cold weather; increase with very high or very low barometer. These observations contribute to the view that the amount of carbon dioxid in the atmosphere is by no means constant under varying conditions.

G. SPEZIA contributes to the *Atti* of the Turin Academy an investigation on the action of water on quartz under pressure. Pfaff had shown, using quartz powder, that at 18° and 290 atmospheres' pressure one part of quartz dissolved in 4,700 parts of water; using plates of quartz, Spezia finds that at 25° and 1,750 atmospheres (in one experiment 1,850 atmospheres) in the space of over five months absolutely no quartz went into solution.

J. L. H.

SCIENTIFIC NOTES AND NEWS.

THE subject of Professor W. P. Mason's address as Vice-President of the American Association for the Advancement of Science (Section C., Chemistry) will be 'Expert Testimony.' The subject of Vice-President L. O. Howard's address (Section F., Zoology) will be 'The Spread of Land Species by the Agency of Man with especial reference to Insects.' The subjects of the other addresses have already been announced in this JOURNAL.

THE party from the zoological department of Columbia University reached Puget Sound, Washington, in the latter part of June, and gave a fortnight to the further exploration of the waters of the Sound. Upon July 8th they started for Sitka, Alaska, where they will remain from four to six weeks, returning to Port Townsend at the close of the season. The party includes Professor Wilson, Dr. Calkins, Professor Lloyd and five others.

PROFESSOR OSBORN has recently returned from a visit to the various parties sent out by the American Museum of Natural History. The systematic collection of vertebrates this year is extended for the first time among the reptilia, and two parties are working in Kansas and Wyoming. Professor Osborn and Dr. Wort-

man made a survey of the Huerfano Tertiary Lake Basin, in southern Colorado, discovered in 1888 by Professor R. C. Hills, of Denver. The main Museum party has been stationed in the Equus Beds of northwestern Nebraska, where a very complete Pleistocene collection has already been obtained. This department of the American Museum has prepared an exhibit of enlarged photographs of eight mounted fossil skeletons in the Museum, and of twelve restorations designed by Charles Knight, for the International Exposition at Brussels. A similar series will be exhibited at the Geological Congress at Moscow, and at the meetings of the American and British Associations in Detroit and Toronto.

WE learn from *Nature* that the Sydney expedition to Funafuti, to make borings in the coral, projected and led by Professor David, started on June 2d, going by steamer to Fiji, and thence by sailing vessel to Funafuti. This expedition has been made possible by the liberality of the mining department of the government of New South Wales, which has supplied all the boring plant free of cost, and by the munificent gift from Miss Walker, of Sydney, of £500, and from the Hon. Ralph Abercrombie of £100, towards the expense of the expedition.

THE Park Board of New York City have finally adopted the plans of the managers of the Botanical Society for the Botanical Gardens in Bronx Park. R. W. Gibson and the Lord & Burnham Company have been appointed architects. The Board of Estimate has been requested to issue bonds to the amount of $500,000 to defray the cost of erecting the buildings.

DURING a lecture by M. Lacaze-Duthiers, professor of zoology at the Sorbonne, the oxyhydrogen generating apparatus exploded and two of the assistants, MM. Brumpt and Lancepaline were injured, the latter somewhat seriously.

THE Council of the Zoological Society of London have conferred the silver medal of the Society on Mr. Alexander White for his contributions to our knowledge of the fauna of Nyassaland.

ON the occasion of his retirement from the chair of practical chemistry in the School of the Pharmaceutical Society of Great Britain, Professor John Attfield, F.R.S., has been the recipient of a testimonial consisting of an autograph album and silver plate. The former contained the names of eminent scientific men of England and the Continent.

MR. JAMES F. BABCOCK died at Dorchester, Mass., on July 19th, at the age of fifty-three years. He was formerly professor of chemistry in Boston University. During his terms of office as State Assayer and Inspector of Milk he made great improvements in methods of testing. He was the inventor of the fire extinguisher which bears his name, and was well known as a lecturer on popular scientific subjects.

MR. CHARLES F. CROCKER, whose death in San Francisco has been announced, was a regent of the University of California and had made many gifts to public and scientific institutions, including Lick Observatory. His will does not contain public bequests.

THE death is announced of Professor W. Preyer, the eminent physiologist, at Wiesbaden, at the age of 56 years.

WE regret to record the following deaths: M. Chudzinski, professor in the Paris School of Anthropology; Dr. E. Le Gros, professor of physiology at the new University of Brussels, known for his contributions to ophthalmology, aged 36 years; Professor W. Marmé, director of the Pharmacological Institute of Göttingen; Dr. Giuseppe Fissore, sometime professor of pathology in the University of Turin, aged 82 years, and Dr. M. Josef Oertel, professor of medicine at Munich.

THE United States Civil Service Commission announces a competitive examination to fill the vacancy in the position of Supervising Architect of the Treasury. The salary of this position, which is one of the most important and responsible under the government, is $4,000 per annum, and it is hoped that architects of high attainments and reputation may be induced by these considerations to enter the competition. It is the desire of the Department to secure a practical architect of high administrative abillty to direct and supervise the work of the office force as well as the contract work

done on public buildings throughout the country.

It is reported that the Secretary of Agriculture will ask Congress at its next session to authorize the establishment of an Agricultural Experiment Station in Alaska. Suitable scientific experiments would be of great value in showing what agricultural products and domestic animals could be introduced to advantage.

According to the New York *Evening Post*, George A. Brill of Poughquog, Dutchess county, who was graduated from Cornell University in 1888, recently received a cable despatch from Li Hung Chang offering him a liberal sum to organize and manage a model farm in China under the government. He will accept the offer, and will soon leave for China to enter upon his duties.

Professor Bessey writes in the *American Naturalist* that he knows from many years of personal experience, and this not in an old and wealthy community, that the purchase of good compound microscopes (duty free), and the installation of small but efficient laboratories in secondary schools, is as easily accomplished for botany as is the purchase of necessary apparatus and the fitting-up of proper laboratories for chemistry. In the new State of Nebraska nearly every accredited high school is now using the compound microscope in the study of plants selected as types of all the greater groups of the vegetable kingdom.

At the request of Mr. Melvil Dewey, on behalf of the American Library Association, the U. S. government has agreed to issue postal cards of the standard library size for index cards.

The second International Library Conference was opened on July 13th in London by the Lord Mayor. Sir John Lubbock gave the presidential address. Papers were subsequently presented by Mr. J. T. W. MacAlister, of the Royal Medical and Chirurgical Society of London; by Mr. Henry Tedder, Mr. Herbert Jones, Mr. Alderman Rawson, Mr. Melvil Dewey and others.

At the recent conversatzione at University College, London, apparatus to be used in a course in experimental psychology was exhibited. The course will be given under the direction of Professor James Sully and Dr. W. H. R. Rivers.

Lord Kelvin has written a letter to the London *Times* stating that in his address at the Pender memorial meeting (quoted in the last issue of this Journal) he inadvertently did serious injustice to the late Sir Curtis Lampson when he said that it was owing to Mr. Pender alone that the Atlantic Telegraph Company was kept afloat from 1858 to 1864. In fact, a large part of the heavy burden of keeping the original Atlantic Telegraph Company alive in the disheartening circumstances of the failure of the 1858 cable, after the short time of its successful working, was voluntarily undertaken by Mr. Lampson when he and Mr. Pender continued to act as directors and nearly all the others, incluing Lord Kelvin himself, resigned.

The new underground railway in London, extending from Liverpool street to Bayswater, has been an engineering feat of considerable scientific interest. The tunnels are steel tubes 11 feet 6 inches in diameter driven through the clay, each tunnel containing one track. The electric equipment, including the elevators, is supplied from America.

The *Railway and Engineering Review*, one of the best of the technical journals, publishes in its issue of July 3d an editorial article two columns in length advocating the use of the metric system and maintaining that no great inconvenience would be caused in its practical application.

UNIVERSITY AND EDUCATIONAL NEWS.

The Pennsylvania Legislature appropriated $200,000 to Lehigh University, and Governor Hastings has signed bills granting $150,000. The funds of Lehigh University are chiefly in stocks of the Lehigh Valley Railroad left by the late Asa Packer and no dividends have been paid for three years.

The will of the late Alexander Wheelock Thayer gives $30,000 (subject to a small annuity) to Harvard University as an endowment fund to assist poor students.

MR. D. A. BEAMER has given $10,000 to the Laman Missouri Educational Association. The Boston *Transcript*, in announcing this gift, remarks: "The Association has a capital of $20,000, fully paid up, and will establish and operate an up-to-date college of a high order!"

THE following advancements and new appointments in the scientific departments of the University of Texas for the year 1897–'98 have been made: Thomas U. Taylor has been advanced from the grade of associate professor of applied mathematics to that of professor; Dr. Sidney E. Mezes from the grade of adjunct professor of philosophy to that of associate professor; Dr. Henry Winston Harper from the grade of adjunct professor of chemistry to that of associate professor, and W. W. Norman from the grade of adjunct professor of biology to that of associate professor. Dr. Joseph Baldwin, the venerable professor of pedagogy, has been made emeritus professor, and Mr. William S. Sutton, City Superintendent of the Houston Schools, has been elected professor of pedagogy; Mr. E. P. Schoch returns to the University as instructor in chemistry.

AT the Oshkosh Normal School the following appointments have been made: H. Fling, Ph.D., Chicago, to the chair of biology and chemistry; Frank A. Mitchell to the chair of geography; F. D. Sherman, Ph.D., Leipzig, to the chair of pedagogy and psychology.

AT a meeting of the electors to the Savilian professorship of geometry held on July 8th, Mr. William Esson, M. A., F. R. S., fellow of Merton College, was elected professor in the room of the late Professor Sylvester.

MR. ERNEST WILLIAM MACBRIDE, fellow of St. Johns College, Cambridge, and senior demonstrator in the zoological laboratory of the University, has been appointed to the new chair of zoology in McGill University, endowed by Sir Donald A. Smith. Mr. MacBride has held the Hutchinson studentship for research at Cambridge and was awarded the Walsingham Medal in 1895. He has published an important series of Monographs on the Echinodermata.

UNDER the will of Mrs. Gee, widow of the late Robert Gee, lecturer on the diseases of children in the medical school associated with University College, Liverpool, that college receives over £7,000 for the purpose of advancing the medical department and promoting study and research in medical science. It has been decided by the medical faculty to institute a Robert Gee fellowship in anatomy of the value of £100 for one year, and four entrance scholarships of £25 each for one year.

THE Council of St. Hugh's-hall, Oxford, has recently accepted from Miss Clara Evelyn Mordan a donation of £1,000 to found a scholarship to be called by her name.

THE *Lancet* states that Professor Engelman, in taking the late Dr. Du Bois-Reymond's chair at Berlin, is arranging certain changes in the Physiological Institute and its four departments. The first, for microscopical and biological work, will remain under the charge of Professor Fritsch. Similarly, the second, for chemical physiology, will continue under its present director, Professor Thierfelder. The third, for special physiology, will be greatly enlarged, and the professor himself will take part in its work in conjunction with the present director, Dr. Immanuel Munk. The fourth department, for physical physiology, will also be largely increased; it will be called the Department for the Physiology of the Sensory Organs and will remain under the direction of Professor König. In addition to extensive new buildings, the supply of apparatus will be largely augmented. The lectures will be given by the professor in a course running through two semesters, but during the last four weeks in the summer Professor König will lecture on the sensory organs, and during the first four weeks of the winter Professor Thierfelder will lecture on physiological chemistry.

PRESIDENT ANDREWS, of Brown University, has been requested by a committee of the Board of Trustees not to discuss the question of the free coinage of silver, and has consequently been compelled to resign from the presidency of the University. The trustees did not base their action on the supposed evil effects of President Andrews' teaching, but on the alleged ground that the University had, through the

expression of his views, lost gifts and legacies and might lose more. The occurrence is extremely regrettable. It might have been better if President Andrews had not felt called upon to advocate the views of a political party unpopular in Rhode Island, but if the trustees have by their action increased 'gifts and legacies' to Brown University they have done harm to the cause of education. The first part of President Andrews' letter of resignation is as follows:

Believing that, however much I might desire to do so, I should find myself unable to meet the wishes of the corporation as explained by the special committee recently appointed to confer with me on the interests of the University without surrendering that reasonable liberty of utterance which my predecessors, my faculty colleagues and myself have hitherto enjoyed, and in the absence of which the most ample endowment for an educational institution would have but little worth, I respectfully resign the presidency of the University, and also my professorship therein, to take effect not later than the first day of the approaching September.

DISCUSSION AND CORRESPONDENCE.

AMPHIBIA OR BATRACHIA.

Professor Gill in his excellent address 'Some Questions of Nomenclature,' delivered at the Buffalo meeting of the American Association for the Advancement of Science,* makes the following remarks about the name *Amphibia* (p. 600): "Why should the name Amphibia disappear and Batrachia and Reptilia usurp its place? Amphibia is a far better name for the Batrachia, and in every way defensible for it. The name had especial relation to it originally, and it was first restricted to it as a class." In the Editor's Table of the *American Naturalist*, December, 1896, p. 1027, we read the following from the pen of Professor Cope: "It is difficult to eradicate from scientific literature a name or word which has become current, even after it has been found to be an expression of ignorance or error. Thus some names introduced into zoology die hard. Perhaps the most pestilent pretender of the list is the word Amphibia, which is so frequently used instead of the proper name of the class Batrachia. The name Amphibia was originally applied to a combination of the Reptilia and Batrachia, before the fundamental differences between the two were known. When the Batrachia were first separated from the Reptilia the new name was naturally applied to the new division, and the name Amphibia would have been more applicable to the larger division of its former self, *i. e.*, the Reptilia. As, however, its definition accorded with neither the Reptilia nor Batrachia, it was not used for either; nor was it introduced to take the place of Batrachia with a definition, until a few years ago by Huxley. This was done in defiance of the universal usage of naturalists at the time, and probably in ignorance of the real state of the case, since it frequently happens that men engaged in the real work of biological science find questions of names irksome and stupid. Nevertheless it is a distinct advantage always to have but one name for one thing, and that name should be the oldest which was applied to the thing in question as determined by the definition given. Applying this principle, the name Batrachia has a quarter century priority over Amphibia."

I shall show that the opinion of Professor Gill is the only one that can be accepted.*

In the 10th edition of Linné† we have the following:

Classis III. *Amphibia.*

I. *Reptiles* os respirans: Pedes quattuor.

103, *Testudo*; 104, *Draco*; 105, *Lacerta*; 106, *Rana.*

II. *Serpentes*, os respirans, Pedes Pinnæve nullæ.

107, *Crotalus*; 108, *Boa*; 109, *Coluber*; 110, *Anguis*; 111, *Amphisbæna*; 112, *Cæcilia.*

III. *Nantes*, Spiracula lateralia, Pinnæ natatoriæ.

113, *Petromyzon*; 114, *Raja*; 115, *Squalus*; 116, *Chimæra*; 117, *Lophius*; 118, *Acipenser.*

The next author of importance to be mentioned is Alexandre Brogniart. His 'Essai

* Science, N. S., Vol. IV., No. 95, Oct. 23, 1896, p. 581–601.

*Nine years ago I followed Cope (Beiträge zur Morphogenie des Carpus und Tarsus der Vertebraten I. Theil. Batrachia. Jena, Gustav Fischer), but later I found that I was mistaken.

† Caroli Linnæi Systema Naturæ. Tomus I. Editio Decima, Reformata Holmiæ. 1758. Pp. 194–238.

d'une classification naturelle des Reptiles' was published in 1799.*

Brogniart divides the Reptiles into four orders: *Chéloniens*, *Sauriens*, *Ophidiens*, *Batraciens*, and gives the following characters: (Bull. Sciences Soc. Philom, No. 35, pp. 81–82. 1800):

"1er Ordre: Les *Chéloniens* (il renferme les tortues). Ces Reptiles n'ont point de dents enchâssées, mais leurs mâchoires sont enveloppées de gencives cornées tranchantes, leur corps est couvert d'une carapace. Il est bombé. Ils ont deux oreilettes au cœur, un estomac plus volumineux que les autres reptiles, un canal intestinal garni d'un cæcum, ils s'accouplent et pondent des oeufs à coquille calcaire solide. Ils se nourissent en' grande partie de végétaux."

2e Ordre: Les *Sauriens* (renferment les crocodiles, iguane, dragon, stellion, gecko, caméléon, lézards, sinque, chalcide).

Tous ces animaux ont des dents enchassées, deux oreilettes au cœur, des côtes et un sternum, le mâle n'a un organe extérieur de génération; ils s'accouplent réellement, pondent à terre des oeufs à coquille calcaire, d'où sortent des petits qui ne subisent pas de métamorphoses. Ils ont des plaques écailleuses ou des écailles sur le corps.

3e Ordre: Les *Ophidiens* (renferment les genres connus sous le nom général de serpents).

Ils se rapprochent plus des reptiles des premiers ordres que de ceux du quatrième, comme eux ils ont de longues côtes arquées, le mâle a un organe extérieur de génération, ils s'accouplent réellement et pondent des oeufs á coquille calcaire d'où naissent des petits en tout semblable à leurs parents; mais ils diffèrent des Sauriens, parce qu'ils n'ont qu'une oreillette au cœur, point de sternum, que les mâles ont une verge double, quils pondent des oeufs à coquille calcaire molle et qu'ils n'ont point de pattes.

4e Ordre: Les *Batraciens*, (contenant les crapauds, les raines, les grenouilles et les salamandres).

Ces animaux diffèrent autant des trois premiers ordres, qu'ils se conviennent entre eux, et l'auteur prouve que les salamandres qu'il a placées dans cet ordre, n'ont d'autre analogie avec les lézards, parmi lesquels on les avait mises, que d'avoir comme éux le corps allongé, des pattes et une queue.

Tous ces reptiles ont d'ailleurs une seule oreillette du cœur, points de côtes ou seulement des rudiments de ces os, la peau nue et des pattes, le mâle n'a aucun organ extérieure de génération et il n'y a point d'accouplement réelle, la plus part du temps les oeufs, sont fécondés hors du corps de la femelle. Ces oeufs sont sans coquille et pondus dans l'eau; les petites qui en sortent ont des branchies à la manière des poissons, et diffèrent de leurs parents pendant les premiers moments de leur vie, ils se rapprochent par cela même des poissons; ces animaux doivent donc être placés dans l'ordre naturelle de la fin de la classe des Reptiles et immédiatement avant celle des poissons."

The close relationship between the frogs and toads and the salamanders had already been observed by Laurenti (1768) and Lacépède (1788–89), but they did not make any use of this fact in their classifications. It is the merit of Brogniart to have united these forms in a single order of his reptiles, which he called *Batraciens*. At the same time it is evident that he did not oppose the order Batraciens to the rest of the *Reptiles*, but gave it the same value as to the single orders *Chéloniens*, *Sauriens* and *Ophidiens*.

The first Latin names were given to these orders by Treviranus in 1802 and by Shaw in the same year.

Treviranus* uses the name *Amphibien* for the

*Brogniart, Alexandre, Essai d'une classification naturelle des Reptiles. Magazin encyclopédique ou Journal des Sciences, des Lettres et des Arts, rédigé par A. L. Millin. Tome V., pp. 184–201, 1799, reprinted in Bulletin des Sciences, par la Société Philomatique, No. 35, Ire Partie, pp. 81–82, Paris, Pluviose, an 8 de la République. IIe Partie No. 36, pp. 89–91, pl. VI. Ventose, an 8 de la République. (January 21st–March 19th, 1800.) The same paper, more extensive, was published in Mémoires présentées à l'Institut des Sciences, Lettres et Arts, par divers Savans, et dans les Assemblées. Sciences mathématiques et physiques, Vol. I., pp. 587–637, 2 pl., Paris, XIV.—1805; also separate, Paris, Baudouin, Imprimeur de l'Institut National. Prairial An XIII.—1805.

*Treviranus, Gottfried Reinhold, Biologie, oder Philosophie der lebenden Natur für Naturforscher und Ärzte. Bd. I., pp. 260–265 Göttangen, 1802.

whole group, and following Brogniart he divides it in four orders:

I. Schildkröten. *Testudines.*
II. Eidechsen. *Lacertæ.*
III. Schlangen. *Serpentes.*
IV. Frösche. *Ranæ.*

Shaw * uses the same names for the four orders of his *Amphibia* in the following order: I. *Testudines.* II. *Ranæ.* III. *Lacertæ.* IV. *Serpentes.*

We see the *Latin* name *Batrachia* was not used at all by Brogniart, as stated by Professor Cope in 1889 (Batrachia of North America, p. 17). The first *Latin* name for the order is *Ranæ*, Treviranus, and if we would follow Cope's opinion about this question we should have to call the class *Amphibia Ranæ.*

In 1804 Latreille † published his 'Tableau méthodique des Reptiles.'

Classe troisième.

Reptiles, Reptilia.

I. Des pattes, ayant des doigts onguiculés, ou point des pattes; jamais de branchies ni de métamorphose.

Ordre I. *Chéloniens*, Chelonii. Des pattes; corps enveloppé dans une boîte osseuse.

Ordre II. *Sauriens*, Saurii. Des pattes; corps nu.

Ordre III. *Ophidiens*, Ophidii. Point des pattes.

II. Doigts des pattes n'ayant pas d'ongles; des branchies, du moins pendant un temps; de métamorphose.

Ordre IV. *Batraciens*, Batrachii.

We see, that Latreille divides the Reptilia in two groups, without giving special names to them. The first group contains the Orders *Chelonii* (*Testudines*, Treviranus, Shaw, 1802), *Saurii* (*Lacertæ* Treviranus, Shaw), and *Ophidii* (*Serpentes* Treviranus, Shaw); the second one the order *Batrachii** (*Ranae* Treviranus, Shaw).

Two years later, in 1806, C. Duméril † used the Latin names: Class, *Reptilia*, with the orders, *Chelonii, Saurii, Serpentes, Batracii.*

Gravenhorst,‡ in 1807, calls the orders: *Chelonia, Sauria, Ophidia, Batrachia.*§

Oppel ‖ opposed the 'Batraciens' to the other Reptilia, as can be seen from his diagnosis, but he did not give any special names to the combined opposed orders.

Classis Reptilia. Animalia vertebrata; pulmonibus; sanguine frigido; pilis, mammellis, plumisque carentia.

Corpus
- obtectum
  - testa, sternoque.....I. *Testudinata* (Klein).
  - squamis, costis proprie dicti.....II. *Squamata* (Oppel).
- nudum, *i. e.*, nec testa, nec squamis; genitalia exteriora nulla; metamorphosis...III. *Nuda* (Klein).

Oppel was also the first one who placed the *Cœcilians* in the Amphibia; he also placed *Anguis* in the *Lacertilia.* The affinity between *Anguis* and the *Lacertilia* had been recognized, however, already one year before by *Lehmann.*¶

Now follows the important paper of de Blainville,** published in 1816. He divides the reptiles into two classes or subclasses, as will be seen from his diagram.

*This is the first occurrence of the Latin form of Batraciens Brogniart.

† Duméril, Constant. Zoologie Analytique ou Méthode Naturelle de classification des Animaux. Paris, MDCCCVI., pp. 74–95.

‡ Gravenhorst, I. L. C. Vergleichende Übersicht der Linneischen und einiger neueren zoologischen Systeme. Göttingen, 1807, p. 397.

§ This is the first use of the name Batrachia.

‖ Oppel Michael. Die Ordnungen, Familien und Gattungen der Reptilien als Prodrom einer Naturgeschichte derselben. München, 1811, 86 p.

¶ Lehmann, C. D. W. Über die Zerbrechlichkeit der Blindschlangen und die Übereinstimmung des inneren Baues derselben mit den Eidechsen. Magaz. der Gesellsch. Naturf. Freunde. I-Berlin. Jahrg. IV., pp. 14–31, 1810.

**Blainville, H. de. Prodrome d'une nouvelle distribution systematique du règne animal. Bulletin des Sciences par la Société Philomatique de Paris. Année 1816, pp. 113–124.

*Shaw, George. General Zoology or Systematic Natural History, Vol. III., Part I., Amphibia, p. 5. London, 1802.

† In the Nouveau Dictionnaired' Hist. Nat., Vol. 24, p. 61.

Classes III. et IV. *Reptiles* Hétéro ou Erpétozoaires. Squammifères et Nudipellifères.

I^re^ Sous-Classe *Ornithoïdes*, Ecailleux. ou III^e^ Classe *Squammiferes.*	O. I. *Chéloniens* ou Tortues.	
	O. II. *Emydo-Sauriens*, ou Crocodiles.	
	O. III. *Bispeniens*	I^re^ Sous-O. Sauriens.
		II^e^ Sous-O. Ophydiens.
II^e^ Sous-Classe *Ictyoïdes* Nuda ou IV^e^ Classe *Nudipelliferes*	O. I. Batraciens, ou Grenouilles.	
	O. II. Pseudosauriens, ou Salamandres.	
	O. III. Amphibiens, ou les Protées et les Sirènes.	
	O. IV. Pseudophidiens, ou Cœcilies.	

De Blainville makes the following very interesting remarks:

Les noms d'*Ornithoïdes* et d' *Ictyoïdes* employés dans le cas ou les reptiles seraient considerés comme une seule classe, indiquent que les premiers sont formés d'après le plan des oiseaux, et les seconds d'après celui des poissons. P. 119.

Merrem * (1820) divides the *Amphibia* Linné into two classes:

1. *Pholidota:* Corpus *pholide tectum.*

The *Pholidota* contain the orders: *Testudinata, Loricata, Squamata.*

2. *Batrachia:* Corpus *glabrum* aut *verrucosum.*

The *Batrachia* the orders: *Apoda, Salientia, Gradientia.*

The group *Amphibia* Linné is still retained, but it is divided into two classes: *Pholidota* and *Batrachia.*

Two years later, in 1822, de Blainville † separated completely the Amphibia from the Reptilia. Here is his general classification of Vertebrates (plate 2):

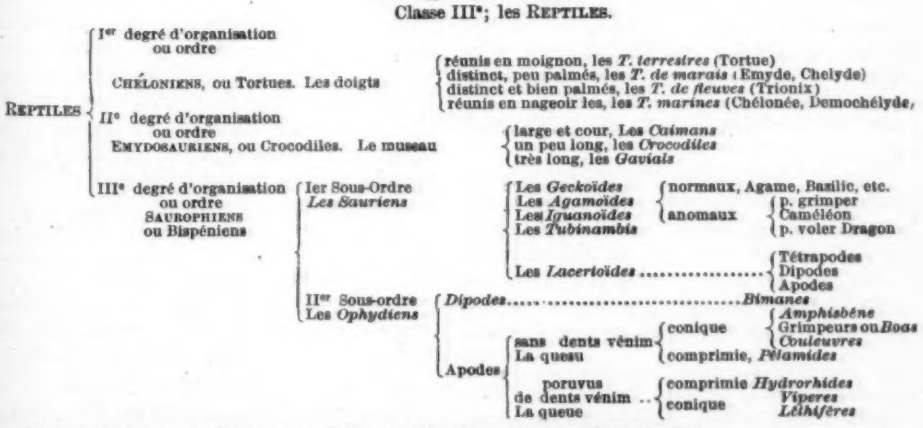
TYPE I.

OSTÉOZOAIRES ou A. VERTÉBRÉS.

Sous—Type I.	*Vivipares.*
Homme.	
Piliféres.	MAMMIFÉRES.
Sous—Classe I.	*Monodelphes.*
Sous—Classe II.	*Didelphes.*
Sous—Type II.	*Ovipares.*
Pénnifères.	OISEAUX.
Squammifères.	REPTILES.
Nudipellifères.	AMPHIBIENS.
Pinnifères.	POISSONS.

The special classification of the *Reptilia* and *Amphibia* is given in the following (plate 5).

Type I, OSTÉOZOAIRES.
Sous-Type II, OVIPARES.
Classe III^e^; les REPTILES.



* Merrem, Blasius. Tentamen Systematis Amphibiorum. Marburgi, MDCCCXX.

† Blainville, Ducrotay de, De L'organisation des Animaux, ou Principes d'Anatomie Compareé. Tome I. Contenant la Morphologie et l'Aistésologie Paris, 1822 (pl. 2 and pl. 5 at the end of the volume). This is the only volume that has been published.

Classe IV^e^; LES AMPHIBIENS

AMPHIBIENS	I^er^ degré d'organisation ou ordre BATRACIENS	Sous-ordre	I. *Aquipares.* Rainette, grenouille, Crapaud
			II. *Dorsipares.* Pipa.
	II^e^ degré d'organisation, ou ordre PSEUDOSAURIENS, ou Salamandres.		
	III^e^ degré d'organisation, ou ordre SUBICHTHYENS. Les Protées, Sirènes.		
	IV^e^ degré d'organisation ou ordre PSEUDOPHYDIENS, ou Coecilies.		

Three years later Latreille* used the Latin names *Reptilia* and *Amphibia* for de Blainville's classes *Reptiles* and *Amphibiens*, and these names ought to be used. Gray† in the same year, but later used the same names as distinct classes.

This name is used to-day all over Europe, France excepted.

Latreille's characters are the following:

P. 90. "*Première Classe.* REPTILES. REPTILIA.

"Ils ne respirent, et en tout temps, que par des poumons. Le cœur a deux ventricules et deux oreillettes. Les mâles ont une verge quelquefois double ou fourchue et s'accouplent. Plusieurs sont sujets á des mues complètes, ou se défont de leur peau, mais aucun n'éprouve de métamorphose. Le corps est plus souvent garni d'écailles ou emboîté; les pieds sont toujours armés d'ongles très-sensibles. La coque des oeufs est dure ou du moins coriace."

P. 103–14. "*Seconde Classe. Amphibiens.* AMPHIBIA.

"Ici les deux poumons sont accompagnés, soit dans le jeune âge, soit pendant toute la vie, de branchies. Le cœur n'a qu'un ventricule et qu'une oreilette, tant que les branchies persistent, un tronc artériel et dorsal tient lieu du ventricule qui manque, savoir la gauche il est remplacé, lorsqu' elles disparaissent, par une artère dorsale. Les mâles n'ont point de verge. L'accouplement n'est que similué, c'est-à-dire qu'il ne consiste que dans de simples embrassements, durant lesquels les mâles fécondent les oeufs, á mesure qu'ils sortent. Les petits naissent sans pattes, et subissent de véritables métamorphoses. La peau est toujours nue, et les ongles des pieds sont nuls ou rarement sensibles. Les oeufs sont réunis, et leur coque est membraneuse. Ces animaux vivent pour la plupart dans les eaux ou les lieux humides."

FEBRUARY 14, 1897. G. BAUR.

* Latreille, Pierre André, Familles naturelles du régne animal, Paris, 1825, pp. 90–103.

† Gray, John Edward. A synopsis of the genera of Reptiles and Amphibia with a description of some new species. The Annals of Philosophy, New. Ser., Vol. X. London, Sept., 1825, pp. 194–213.

CORRECTION CONCERNING MR. RHOADS' USE OF THE NAME BASSARISCUS RAPTOR (BAIRD).

IN a recent paper in the Proceedings of the Biological Society of Washington* I quoted two statements, which were in part contradictory, from a paper by Mr. S. N. Rhoads respecting the proper name for the Oregon Bassarisk. In so doing I made a stupid blunder, for one of the statements in question was quoted by Mr. Rhoads, whose own remarks in this particular were not inconsistent.

C. HART MERRIAM.

SCIENTIFIC LITERATURE.

Report on Vital and Social Statistics in the United States at the Eleventh Census, 1890. Part II., Vital Statistics. Cities of 100,000 Population and Upward. By JOHN S. BILLINGS, M.D. Washington, 1896 [Received May, 1897], pp. 1181.

Now that statistical studies of variation and

*Proc. Biol. Soc. Wash., XI., 186, July 1, 1897.

the phenomena of life are coming into so much favor among students of evolution, the present volume possesses a distinct value as a biological treatise, in addition to its obvious practical utility. It may serve at once as an encouragement and a warning to ardent statisticians, because, while many of the facts it sets forth are important and interesting, the closer it is studied the stronger grows the conviction that vital statistics need to be examined with extraordinary caution before being accepted at their 'face-value.' *Homo sapiens* is an animal whose habits are better known to us than those of any other, and we have exceptional facilities for estimating the factors which control his development and evolution. Accordingly, we readily perceive the more important probable sources of confusion in the statistics, as, for example:

(1) The 28 cities of the size indicated in the title had an aggregate population of 9,697,960, of which 4,850,653 were males and 4,847,307 females. Thus it might be inferred that the males of the human species were more numerous than the females, but for the recollection that large cities attract great numbers of men who either have no families or leave them elsewhere. Taking the cities separately, the majority had more females than males, but the following eleven had an excess of males: Buffalo, Chicago, Cleveland, Denver, Jersey City, Kansas City, Minneapolis, Omaha, Pittsburg, St. Louis (white) and St. Paul. It is significant that while Omaha had a population of 80,108 males and only 60,344 females, those under one year of age consisted of 1,411 males and 1,422 females, showing an excess of female births, in accordance with current expectations.

It is, however, very remarkable to find that in a number of cities there was an excess of male babies under one year of age, showing apparently an excess of male births. Thus Jersey City had 2,007 males and 1,966 females under one year; Chicago had 15,281 males and 14,823 females under one year. But this result is further complicated by the fact that there was a considerable excess of male mortality under one year; thus in Chicago the deaths under one year were 233.95 males and 190.72 females per 1,000 population of corresponding age. In every city the male mortality under one year exceeded the female, often greatly exceeding it. Thus including still-births, we get the following striking results:

Total deaths under one year.

	Males.	Females.
Buffalo,	1,069	817
Cleveland,	1,155	835
Philadelphia,	3,707	3,055
New Orleans,	1,084	844

and so forth.

Now how are we to account for an excess of male births, combined with a remarkable excess of male mortality, during the past year? I have heard it stated that the slightly larger average size of the male head leads to an increase of the number of still-births, but this obviously will only account for a small proportion of the facts here before us. It seems to the present writer that some light may be thrown on the problem by the theory, adopted by some biologists, that the sex is determined at an early age by the conditions of the nutrition of the germ, favorable conditions producing a preponderance of females, unfavorable of males. If this is so, immediately we see the meaning of the above statistics. Omaha, which was the most healthy of the towns discussed, according to the data given, had an excess of female babies; other cities, notoriously containing unhealthy and crowded wards, show an excess of male babies. Further, if disadvantageous conditions lead to an excess of males, it is easy to understand why those males, on the average, should be less able to survive the first year. Hence the excess of male deaths, even when there was an excess of female births. It is to be supposed that those families and wards in which occurred the greater part of the male deaths would show an excess also of male births, though the city as a whole might not show it.

(2) Comparing 1880 with 1890, there is shown a great increase of infant mortality. Thus, for example:

Proportion of deaths under 1 year per 1000 births.

Newark,	under	150	in	1880,	over	250	in 1890
Jersey City,	"	175	"	"	"	225	" "
Denver,	"	125	"	"	"	200	" "
Rochester	"	100	"	"	"	150	" "

and so forth.

Only three or four cities showed improvement, the most marked being St. Louis.

In studying these facts, there seems to be no escaping the conclusion that infant mortality in the large cities is largely on the increase, but it is probable that meteorological conditions may have affected the statistics, *e. g.*, it was perhaps wetter in 1890 than in 1880. However, on examining the causes of mortality for the two years, we get clearer evidence. 1890 shows a decided increase in 'inanition,' and also 'debility and atrophy.' There is also a marked increase in bronchitis and pneumonia. There is a decrease in convulsions and also in cholera infantum as compared with 1880.

(3) It appears that the colored have an almost uniformily higher death-rate than the whites; and this, as a general rule, is no doubt true; but the negro is known to be less susceptible to malaria than the white, yet, owing to his mode of life, his mortality from this cause is much greater in the cities discussed. Again, it appears from the tables that the death-rate of the native whites is greater than that of the foreign whites in most cities, but, as Dr. Billings points out, this must be connected with the fact that the native whites include a much larger proportion of young children. It is interesting to note that in New Orleans the death-rate of the foreign whites was much greater than in any other of the cities, while that of the native whites was less than in many of the cities. In connection with this we observe that the death-rate from malaria in New Orleans was more than double that in any other of the cities, and that it was much greater among the foreign whites; hence it is fair to assume that the native whites of New Orleans exhibit the results of evolution against this disease.

It may be here remarked that the mortality from typhoid fever was greater in the great cities of the United States than in those of England, France or Germany; and in the United States the foreign-born suffered markedly more from this disease than the native-born. Hence perhaps we may assert that the natives of the United States exhibit the results of evolution against typhoid an evolution more marked than that of European nations.

The death-rate of the colored from consumption was more than twice as great as that of the whites. Curiously, it was about twice as great among the children of mothers born in Ireland as among those of mothers born in Germany, and more than three times as great as among those of mothers born in the United States. This may be largely due to the manner of life of the Irish, but it does appear that they are naturally more susceptible to this disease than Germans or Americans. Erroneous conclusions might be drawn from the fact that Denver has a much higher death-rate from consumption than Pittsburg or Kansas City, did we not remember that very many consumptives go to Denver and die there.

In another part of the book are given colored maps of the cities, showing by different degrees of shading the death-rates in the several wards. Information is also given which enables one to form some opinion as to the causes of the remarkable differences between the healthfulness of the wards in all of the cities. These and many other matters might be discussed at length, but enough has been said to show that Dr. Billings' volume should be of great value not only to social reformers, but also to biological students. It may be that in the study of the facts these different classes of individuals will find a common ground, and the teachings of science will ultimately be heard in no uncertain way from the political platform, setting forth truths which will surprise many comfortable and self-satisfied individuals.

T. D. A. Cockerell.

Mesilla, N. M., June 25, 1897.

GEOLOGIC ATLAS OF THE UNITED STATES. FOLIO 24, THREE FORKS, MONTANA, 1896.

This folio, by Dr. A. C. Peale, consists of 5 pages of text, a topographic sheet (scale 1:250,000), a sheet of areal geology, one of economic geology, one of structure sections, and one giving a generalized columnar section for the district.

The area covered comprises the square degree which lies between the meridians 111° and 112° and the parallels 45° and 46°, in the southwestern, mountainous portion of Montana, and includes 3,354 square miles. In the extreme

southeast corner the Yellowstone National Park barely falls within the area. The folio derives its name from the valley in which the Jefferson, Gallatin and Madison rivers unite to form the Missouri. The 'Three Forks' Valley is important from an historic standpoint, as being the point which Lewis and Clark reached in July, 1805, when they named the three confluent branches of the Missouri.

The text begins with a general description of the geography and topography of the region, and then takes up the general geology. The oldest rocks in the region are the crystalline schists and gneisses, designated as of Archean age, which in pre-Cambrian time formed a land mass comprising nearly all the area included in the map. While the Algonkian beds were being deposited to the extent of from 6,000 to 12,000 feet, there was a gradual subsidence of the whole region, and shallow seas for the most part prevailed. During the Paleozoic age there were many minor oscillations of the surface, which were more frequent during Cambrian time than during the deposition of the Devonian and Carboniferous limestones. Toward the close of the Cretaceous period a general elevation began, which was accelerated after the deposition of the Laramie formation. The formation of the mountain ranges, together with the subsequent erosion, resulted in many valleys, which eventually were occupied by fresh-water lakes. These lakes attained their greatest extent in the Neocene period, lasting in all probability until the Pleistocene period was well advanced, and during their earlier stages immense bodies of wind-carried volcanic dust were deposited in their waters, and are now seen as beds of pure white dust. At the same time the dust fell upon the surrounding country, from which it was afterward washed into the lakes, forming an upper series of yellowish and rusty-colored beds. These dust showers destroyed both animal and vegetable life, and the remains carried into the lakes were buried in their deposits, where they are now found as fossil bones and opalized and silicified wood.

Under the 'Description of Rock Formations' are outlined all the formations from the Archean gneisses up through the Algonkian, Cambrian, Devonian, Carboniferous, Juratrias, Cretaceous, Eocene, Neocene and Pleistocene. The rocks of more than half of the area are of sedimentary origin, while the crystalline rocks occupy approximately 1,000 square miles, the remaining third of the area being covered with igneous material. Prominent among the latter are the andesitic breccias which form the main part of the Gallatin Range, the great porphyritic laccolite occupying the center of the Madison Range, and the basaltic plateau which lies west of the Madison Valley.

Under the heading 'Structural Geology,' after a general consideration, the vertical and horizontal movements are discussed, and the development of the lake basins is described. The arrangement of the rock masses is complex, the structure being complicated by laccolites, dikes and surface flows of igneous material. Unconformities exist, showing that areas previously raised to land surfaces and worn down have subsided, have been crossed by an advancing shore, and later have passed beneath the sea.

The lake basins are now the floors of extensive valleys separating the detached mountain ranges, which rise about 6,000 feet above their bases. As the lake deposits are at least 2,000 feet in thickness, the difference of elevation between the bottoms of the lake basins and the summits of the peaks must be at least 8,000 feet. The region was a mountainous one before the development of the lakes; but in the evolution of the existing relief, movements and erosion have both operated to accent the topographic differences.

The principal economic resources of this region are gold, silver, iron ore, copper, limestone and coal. The occurrence of coal in Devonian rocks on the north side of Jefferson Cañon is of geologic interest, although not of much economic importance. The fine pumiceous volcanic dust found in the old lake basins has been utilized to a very limited extent as a polishing material. Brick clays occur and are used to a small extent in a number of localities, especially near Bozeman. In addition to the economic resources just referred to, the sheet of economic geology has indicated upon it the localities of building stone and mineral springs.

GEOLOGIC ATLAS OF THE UNITED STATES. FOLIO 30, YELLOWSTONE NATIONAL PARK, WYOMING, 1896.

THE Yellowstone Park folio, recently issued, consists of six pages of descriptive text, three pages of illustrations, four topographic sheets (scale 1 : 125,000), and four sheets delineating the areal geology of the region.

The general descriptive text, giving a succinct narrative of the geological history and development of the Park country from the time of the earliest continental land surfaces up to and including the hydro-thermal phenomena as seen to-day, was written by Arnold Hague, geologist in charge. It is followed by an account of the sedimentary rocks from the earliest Cambrian deposits to the Tertiary conglomerates, by Walter Harvey Weed, and a detailed petrographical description of the igneous rocks, by Joseph Paxson Iddings.

The area of country covered by the Yellowstone National Park folio lies between parallels 44° and 45°, and meridians 110° and 111°. It is situated in the extreme northwest corner of Wyoming. By far the greater part of the Park is included within the area of the four atlas sheets, but a narrow strip lies to the northward in Montana, and a still narrower strip extends westward into Idaho and Montana. In the organic act establishing the Park, Congress declared that the reservation was 'dedicated and set apart as a public park and pleasure ground for the benefit and enjoyment of the people.' Owing to the marvelous display of geysers and hot springs of the region, and such remarkable physical features as the Grand Cañon and Yellowstone Lake, this folio possesses more than ordinary interest to geologists.

The central portion of the Yellowstone Park is a broad volcanic plateau with an average elevation of 8,000 feet, surrounded on nearly all sides by mountains rising from 2,000 to 4,000 feet above its general level. The continental watershed crosses the Park, separating the waters of the Atlantic from those of the Pacific, the Missouri and the Columbia, by the way of the Yellowstone and the Snake, finding their sources on this plateau.

The oldest rocks of this region are granites, gneisses and schists regarded as of Archean age. They occur in all the mountain uplifts that encircle the Park, but are unknown in the central portion. Around these ancient continental land masses there was deposited a conformable series of sandstones, limestones and shales, extending from the time of the middle Cambrian, the lowest beds exposed through the upper Cambrian, Silurian, Devonian, Carboniferous Juratrias and Cretaceous, including the Laramie sandstone. Nearly every one of these great divisions of Paleozoic and Mesozoic time is characterized by a typical fauna. With the close of the deposition of the Laramie sandstone the conformable series of sediments came to an end. The entire region was elevated above the sea, the elevation being accompanied by plication and folding of strata. This primary orographic uplift which blocked out the main ranges of the northern Rocky Mountains has been designated the post-Laramie movement.

Tertiary sedimentary rocks occupy only small areas in the Park, the greater part of the region being covered by extensive flows of lava. A heavy mass of coarse conglomerate, designated the Pinyon conglomerate, has been referred to the Eocene, and Pliocene conglomerate and coarse sands are well exposed in the escarpments of the Grand Cañon.

Volcanic energy, which has played a great part in the geological development of the country, was connected with the post-Laramie movement and followed closely upon the elevation of the mountains and the accompanying dislocation and compression of strata. The eruptive masses in forcing their way upward sought egress along lines of least resistance, or wherever strain had been greatest in the crumpled sediments. Volcanic outbursts continued on a grand scale throughout Tertiary time.

During the Eocene and Miocene periods enormous volumes of fragmental ejectamenta, largely composed of andesitic breccias, were thrown out. The Absoraka Range was almost wholly built up of volcanic material. Evidence of this long-continued action is shown in the well-preserved fossil floras of Eocene and both lower and upper Miocene age. The famous fossil forests of the Yellowstone are of Miocene age. After a period of great erosion the depressed basin lying between

the encircling ranges was transformed into the present Park Plateau by the extravasation of immense flows of rhyolite of Pliocene age. Still later the recent basalts, the last of the igneous extrusions, poured out over the rhyolite along the ridges of the plateau. A vertical section accompanies the text, showing the order of succession of the extrusive flows from the earliest outbursts to the final dying-out of eruptive energy. It is shown that long-continued currents of heated waters and acid vapors have acted as powerful agents in decomposing the igneous rocks of the plateau, and date back to Pliocene time; at least they were active before glacial ice covered the country. Hot springs, geysers and solfataras are closely associated with the rhyolite, and in fact thermal activity is confined almost exclusively to areas of this rock.

The illustrations relate mainly to the occurrence of both active and dormant geysers and hot springs, or some phase of volcanic geology. The Grand Cañon, well shown in the illustrations, is a profound gorge cut in the Pliocene rhyolite, the brilliant coloring being due to the action of thermal waters.

An Illustrated Flora of the Northern United States, Canada and the British Possessions. By NATHANIEL LORD BRITTON and HON. ADDISON BROWN. Volume II. Portulacaceæ to Menyanthaceæ. New York, Charles Scribner's Sons. Pp. 643. $3.00.

The elaborate review of the first volume of Britton and Brown's 'Illustrated Flora of the Northern United States,' which was given by Professor Conway MacMillan in SCIENCE, renders necessary only a brief notice of the second volume, which has now appeared.

Following the Engler and Prantl sequence, the first volume was made up chiefly of the monocotyledonous plants, which, compared with the other large groups of flowering plants, are probably the least attractive. In the present volume are included such large and well-known families as the Pink family, Crowfoot family, Mustard family, Rose family, Pea family, Carrot family, and the Heath family. As a whole the volume exceeds in interest and attraction the earlier one.

In running through the book a leading feature of excellence impressed upon one is that there are brought together here for the first time in a systematic manner the results of all the recent scattered special papers on our Northeastern plants. For example, the critical work done in the past few years on *Amelanchier Canadensis*, *Cardamine hirsuta*, *Ranunculus repens* and *Agrimonia Eupatoria* is here found carefully collated and systematized, full consideration being given to the conclusions of those who have done the work and whose opinions are therefore most to be depended upon.

A liberal view has been maintained regarding the delimitation of species, the work in this respect standing alone among our recent manuals. There has been a tendency among our manual writers, in case of any difficulty in the definition of specific types, to follow the antique British method of giving up any attempt at segregation and putting a number of diverse forms under one name. The results of the endeavor to give full consideration to valuable critical work is exceedingly gratifying, and will certainly serve to encourage in botanists habits of close observation on our supposedly well-known Eastern flora. No better example of judicious segregation could be cited than the separation from the old *Ranunculus repens* of three additional species, *R. septentrionalis*, *R. hispidus* and *R. macounii*.

In the matter of generic treatment this volume gives a similar impression of liberality, the limitation of genera corresponding very closely in this work with that of continental European authors. As extreme examples of the extent to which the generic segregation has been carried may be cited *Œnothera*, which is here divided into eleven genera. It is clearly a recognized principle throughout the work not merely that a genus is a group which can always be recognized by some one or more invariable technical characters fitting nicely in a key, but that it is a group of plants which resemble each other in what is perhaps best represented in English by the word *style*, and that the question of an arbitrary mark, as it were, is of secondary, not of primary importance.

The drawings, for which the book is most likely to be criticised by botanists of critical

training, are usually excellent, and to the ordinary student, for whose guidance they were evidently more especially intended, they must always prove valuable. The drawings of the violets, for example, are excellent and helpful representations of the different species of that group. In the case of the genus *Myriophyllum* in which the drawings have less of sharpness and more of the character of sketches, the species, which everyone has had difficulty in understanding from mere descriptions, can be readily recognized from the drawings.

Probably the principal fault in the general make-up of the work lies in the separation of the Latin and English indexes, a system which if carried through the third volume would sometimes make it necessary for one unfamiliar with botanical names to look in six different indexes in order to find a particular plant. It is to be hoped that the third volume will contain a single combined Latin and English index to all three volumes.

The impression is strengthened by this second volume that this work marks an epoch in the development of systematic botany in America, combining, as it does, the best of the new ideas which have been current in this country for twenty years and which had their source in the new method of systematic research in which the younger generation had been educated, based on the Darwinian ideas of genetic development.

F. V. Coville.

SCIENTIFIC JOURNALS.

TERRESTRIAL MAGNETISM FOR JUNE.

The first article, by Dr. J. A. Fleming, on 'The Earth a Great Magnet,' gives a popular exposition of the principal phenomena of the earth's magnetism. For many years it has been the custom to have a popular experimental or illustrated lecture delivered during the meeting of the British Association for the Advancement of Science, addressed especially to the artisans of the town in which the meeting takes place. This article gives the text of the discourse delivered by the author before the workingmen of Liverpool at the last meeting of the British Association. Dr. Fleming's most admirable lecture was profusely illustrated by experiments, and was presented before a very large audience in the Picton Hall. It appears in *Terrestrial Magnetism* in full for the first time.

Professor McAdie reviews and summarizes the present state of our knowledge with regard to 'The Electrification of the Atmosphere,' as set forth in the recent publications of Chree, Elster, Geitel and Schuster. The author thinks that there are good grounds for believing that the twentieth century will number among its triumphs a complete electrical survey of the atmosphere. He regards the question as to the relation between the magnetic elements and the atmospheric electric currents as the coming one.

Mr. Littlehales gives an abstract of his recent researches with respect to the establishment of 'Secular Variation Expressions of the Magnetic Inclination.' This investigation is preparatory to a future article which will give the secular change in the direction of a freely suspended magnetic needle at each of twenty-two stations distributed over the globe.

Dr. Bauer, in the next article, 'A Remarkable Law,' presents formulæ giving the diurnal range of the magnetic declination and inclination as simple functions of the magnetic inclination. The formulæ were first found empirically and then deduced theoretically by assuming that the component of the deflecting force producing the angular deflection of the needle from its mean position is inversely proportional to the force exerted on the needle by the earth's permanent magnetism. The formulæ would imply that the lines of equal magnetic inclination represent closely the lines of equal diurnal range. The author finds that the same functions hold with regard to some of the secular and distribution phenomena of the earth's magnetism.

In 'Letters to Editor' is a communication from Professor Hellman regarding Stevins's 'ΑΙΜΕΝΥΡΕΤΙΚΗ;' another from Dr. van Bemmelen discussing the non-cylic phenomena of the diurnal variations, and a third from Drs. von Rijckevorsel and van Bemmelen giving the results of their magnetic observations on the Rigi, made in 1895 and 1896.

Abstracts, Reviews, List of Publications and Notes close the number.